An Analysis of Kazakhstan and Its Energy Sector Using SAM and CGE Modeling

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Abstract

The primary focus of this thesis is the contribution of the oil and gas industry to Kazakhstan's recent economic development. This industry is analyzed in a broader context with the help of the economy-wide modeling tools such as Computable General Equilibrium (CGE) model, Social Accounting Matrices (SAM) and Input-Output models. Such approach allows taking into account all possible linkages the oil and gas industry has with the rest of the economy. The first chapter presents a literature review of CGE studies with an emphasis on applications to energy and transition economies. The thesis proceeds with a description of building a CGE model for Kazakhstan and construction of the SAM. Subsequently, using the above mentioned tools Chapter Four analyses a spillover impact of the oil and gas sector on the rest of the economy. The study establishes that the sector accounted directly and indirectly for about forty percent of economic growth between 2001 and 2005.

The final chapter develops an analytical framework to correct representation of the oil and gas sector in the national accounts distorted by the transfer pricing. When adjusted for transfer pricing, the GDP share of the oil and gas sector in 2001 increases to 16.1 percent compared to the officially reported 8.6 percent.

To the memory of my father

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INTRODUCTION

Since the collapse of the Former Soviet Union in 1991 and subsequent gain of independence, Kazakhstan has undertaken an impressive development journey. Years of economic turmoil and uncertainty in the early transition period have been followed by double digit economic growth and the rising living standards of the population in more recent years. Extensive supplies of natural resources and relatively well-managed macroeconomic policies have advanced Kazakhstan to the rank of successful transition economies. The remarkable rate of economic growth achieved in recent years has raised optimistic expectations among some experts and decision makers about continual economic progress in the long-term perspective. Nonetheless, the country's economic growth remains highly dependent on the export of oil and volatile oil prices. It is unclear whether the spillover effects generated by the oil sector are sufficient to be alternative driving forces of growth. This question is further complicated by the existence of striking inconsistencies in depicting the oil sector in the national statistics. While most experts agree that the real appreciation of the national currency is inevitable, how much of a challenge it poses to Kazakhstan's industry, the so-called Dutch Disease, is less clear. A rapid expansion of the oil sector could lead to the overdependence of the economy on the extraction of natural resources, exposing the country to all the risks associated with such a concentration of activity. On the other hand, it could provide a sustained demand for domestic producers of goods and services with potential prospects for these tertiary industries to expand abroad once they accumulated expertise and gained competitiveness.

To answer these questions the oil industry needs to be considered in a wider context, taking into account all possible linkages this sector has with the rest of the economy. For example, if the oil industry's relative size is underreported by the official statistics, while the data on overall economic development reflects the real situation, some other sectors must have been artificially inflated. This example is not hypothetical and is the consequence of the widespread practice of transfer pricing in Kazakhstan. Nevertheless, it can be effectively addressed using Input-Output and Supply and Use methodology. The spillover effect of the oil industry is likely to manifest itself via several mechanisms, such as an inter-industry supply chain, public and private income and spending, and current accounts. While the Computable General Equilibrium (CGE) modelling technique consistently includes all these mechanisms in a single framework, a Social Accounting Matrix (SAM) can provide a snapshot of the whole economy for a specific time period and could be used for analytic or modelling purposes.

A construction and fine-tuning such techniques just mentioned is not a trivial task and often before any questions can be asked of them, a fair amount of background work needs to be done. The structure of the current thesis reflects this. It starts from providing the economic background of Kazakhstan. It gradually proceeds by reviewing previously conducted studies which used similar methodology, to the construction of the tools required for the analysis. Finally, it concludes with an attempt to provide answers to the research questions posed.

More specifically, Chapter 1 describes the development of Kazakhstan's economy since independence with the focus on energy sector. Population wellbeing using the latest available household surveys also considered in Chapter 1.

Chapter 2 provides a review of studies which used a Computable General Equilibrium (CGE) modelling technique in the areas relevant to this thesis, including energy and the environment, transition and the economy of Kazakhstan. It also briefly covers a theoretical foundation and some general concepts behind CGE models. The aim is to provide a background for the discussion of building a small CGE model for Kazakhstan in Chapter 3 and for some application of this model in Chapter 5.

Chapter 3 presents a detailed description of the CGE model for Kazakhstan. It includes derivation of equations, calibration and estimation of the parameters, balancing of the model and discussion of assumptions used in the process of building the model. The aim is to give an exhaustive description of building a small static CGE model which can be readily modified to suit a specific application in question, such as those considered in Chapter 5.

Chapter 4 explains a construction of a detailed and well documented SAM for Kazakhstan in 2002 with 57 economic sectors and a maximum of 10 household types. It serves as a dataset for the CGE model in Chapter 5. More importantly, it documents a framework for building a SAM for Kazakhstan and similar countries. A highly aggregated SAM is constructed first based on the national accounts. Then a disaggregated Input-Output data is reconciled with the aggregated SAM using a powerful optimization procedure. Data from the detailed Kazakhstan Household Budget Survey is reconciled with the macro-SAM and I-O, which allows for distinguishing between several household types. Finally, the adjustments required for the SAM to be usable in a standard CGE model as described in Chapter 3 are outlined.

Chapter 5 attempts to answer the question of to what extent Kazakhstan's current booming economic development has been driven by the thriving oil industry. Using a slightly modified version of the CGE model developed in Chapter 3 the average annual impact of the expansion of the oil industry on the economy is simulated to find how much of the total actual economic development can be attributed to the oil industry. It is shown how the expansion of minerals production spillovers to the rest of the economy via inter-industry linkages, final demand and other mechanisms. Additionally, Kazakhstan's household budget survey and results of the model simulation help to estimate the impact of the oil and gas industry expansion on income inequality and poverty in Kazakhstan.

The final Chapter 6 develops an analytical framework based on the SUT and IO tables to address the widespread practice of transfer pricing in Kazakhstan's oil and gas industry. Transfer pricing if not dealt with appropriately may significantly affect the GDP structure and make the international comparison inconsistent. Applying this framework to 2001 and 2005 data shows significant changes in the value added share of the oil and gas sector, although comparing different time periods demonstrates a gradual improvement in the national statistics. The degree to which transfer pricing can affect the results of CGE modeling in Chapter 6 are also investigated.

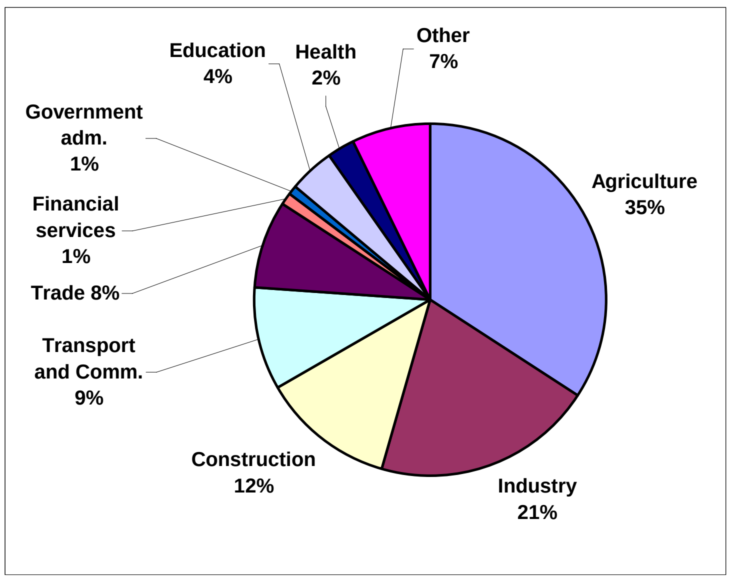
CHAPTER 1

Overview of the Kazakh Economy and Energy Sector

1.1. Beginning of Transition

In 1990 Kazakhstan was a small economy largely dependent on import of manufactured goods from Russia and other Soviet Union republics and exporting mostly raw materials and agricultural products. Its economy was dominated by agriculture which comprised 34 percent of GDP followed by services, which including transport and trade represented approximately 33 percent of GDP. Industry accounted for 20.5 percent share in 1990.

Figure 1.1. Structure of GDP by Value Added in 1990

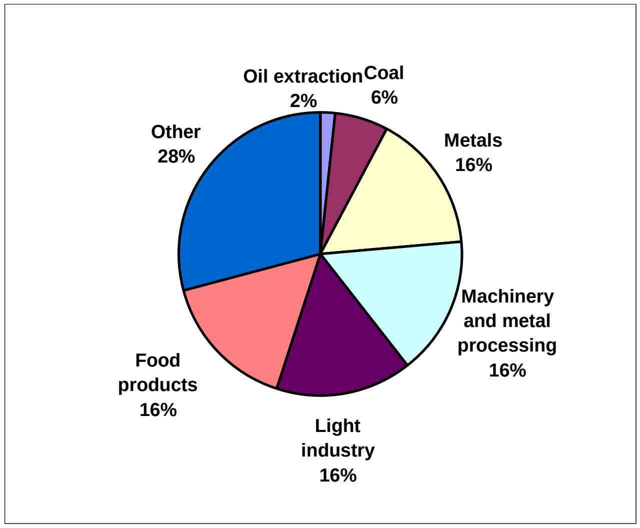


Source: Author's calculations based on ARK statistics.
**"Other" category of GDP includes net indirect taxes*

The break down of industrial output shows that the biggest branches were (in descending order): Food products – 15.9 percent; machine-building and metal processing – 15.9 percent; so called light industry – 15.6 percent; and production of ferrous and non-ferrous metals – 15.6 percent. Although, the level of oil extraction was not small (approximately 26 million tonnes per year or 550 thousand barrels per day) it played a relatively small role in the economy in 1990 representing only 1.8 percent of the total industrial production.

That was partly due to artificially low domestic prices on energy goods that prevailed in the Soviet Union republics.

Figure 1.2. Structure of Total Industrial Production in 1990



Source: Author's calculations based on ARK statistics.

Oil was not a major trading commodity either, comprising only 8.5 percent of export. Agriculture and food products had the largest share of export – 25.4 percent (with 19 percent agriculture and 6.4 percent food products), followed by the production of metals with 19.4 percent, and light and chemical industries with 16.4 and 11.6 percent accordingly. Import was dominated by the machinery and metal works (31 percent) and otherwise was similar to the export pattern. The economy was closely interlinked with Russia with about 60 percent of total exports and two thirds of total imports in the 1988-1989 (World Bank, 1993).

Table 1.1. Composition of Trade in 1990

	Export	Import
Coal	3%	1%
Heavy manufacture	8%	31%
Oil and Gas	9%	7%
Metals	19%	7%
Agriculture and food	25%	13%
Other*	35%	42%
Total	100%	100%

Source: World Bank (1993)
** Includes power, light manufacture etc.*

The collapse of the Soviet Union and subsequent gain of independence in 1991 brought major disruption to the production of goods and services. In Kazakhstan real GDP plummeted to its trough in 1995 falling by a staggering 40 percent of its 1990 level. However, Kazakhstan's experience was rather mild compared to other republics. For example in Georgia, real GDP fell by almost 72 percent by 1994 (see Table 1.3 for details) reinforced by the devastating civil war. Nevertheless, many economists agree that the actual decline in living standards was less severe than official statistics suggest. Among them Pomfret (2005) points out that Kazakhstan's economic performance, especially during the early 1990s, may have been better than it is usually perceived. One reason he argues is that due to a high level of emigration in this period per capita economic indicators fell by much less and hence might be a better indicator Kazakhstan's performance as opposed to total output or GDP measures. The existence of an informal economy would also imply that the actual decline was less severe. Kazakhstan's Statistical Agency provides estimates of the size of an informal economy starting from 1998. Even then its size was estimated at 30 percent of GDP and was probably no less if not more in earlier years (see Table 1.2 for details).

Table 1.2. GDP Share of an Informal Economy by Sector in 1998

Sector	GDP share (%)
Agriculture	7.3%
Industry	2.2%
Construction	0.7%
Trade	6.0%
Hotels and restaurants	0.1%
Transport	3.2%
Communication	0%
Education	1.1%
Health	0.5%
Public and personal services	1.4%
Real estate and rental services	7.6%
Total	**30.2%**

Source: Agency of the RK for statistics

Because production was highly regionalised with often giant firms supplying intermediate inputs to other republics, two main factors are commonly cited as being responsible for the contraction in output in Kazakhstan and other FSU states. One is the breakdown of such inter-industry links within FSU, and the other is the collapse of foreign trade, with Eastern Europe in particular (World Bank, 1993). Thus, at the beginning of transition one of the main priorities for Kazakhstan was to gain access to foreign financial reserves. Instead of single currency and no trade barriers there emerged 15 independent states that started introducing their own currencies and setting up new trade barriers. Suddenly, trade balance mattered. According to the World Bank estimates, external financing requirements for 1993 were in a range of 2.2 to 2.4 billion of USD or approximately 14 percent of GDP. A shortage of financial reserves could have constrained the country's ability to buy vital imports and could put in danger economic recovery. There was a danger of Kazakhstan becoming heavily dependent on external borrowing, thus hindering political and economic security.

For the output recovery production factors had to move or accumulate in the sectors where Kazakhstan had competitive advantage. At that time there were two areas with evident possibility for expansion. First, Kazakhstan had vast amounts of mineral resources, oil in particular. Mineral resources development could provide both sustainable supply of foreign reserves and fiscal revenues. Second, having almost 20% of all arable land in the FSU (World Bank, 1993 estimate), it was reasonable to assume that with the right policies in place, agriculture could have played a major role in economic recovery.

Contrary to the expectations an increase in oil and gas production did not happen until 1997, while agriculture in Kazakhstan suffered the worst decline among all of the former Soviet Union republics including the Baltic States. By the 1998 output of agriculture plunged to 42% of its 1990 level after losing its links with traditional markets and partly because it suffered from a severe drought in 1991. It was further hit by the Russian financial crises in 1998. Export of agricultural and manufactured good suffered most due to sharp devaluation of the Russian rubble, thus losing its share of the market to the Russian farms and firms. In some sense, the Russian financial crisis helped to accelerate structural reforms, although this meant that mining industry (and in later years production of metals) was now virtually the single internationally competitive sector in Kazakhstan. Prior to proceeding to the discussion of further development this paper looks in some more detail at the Kazakhstan's energy sector.

Table 1.3 Real GDP for the CIS Countries (1990 = 100)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Azerbaijan	100	99.3	76.9	59.1	47.5	41.9	42.4	44.9	49.4	53.0	58.9	64.7	71.6	79.6	87.7	110.9	149.1	186.4
Armenia	100	88.3	51.4	46.9	49.4	52.8	55.9	57.8	62.0	64.0	67.8	74.3	84.1	95.9	106.0	120.8	136.9	155.6
Belarus	100	98.8	89.3	82.5	72.9	65.3	67.1	74.8	81.1	83.8	88.7	92.8	97.5	104.3	116.2	126.9	139.6	151.0
Georgia	100	78.9	43.5	30.7	27.5	28.3	31.4	34.7	35.8	36.8	37.5	39.3	41.5	46.1	48.8	53.3	58.3	65.7*
Kazakhstan	100	89.0	84.3	76.5	66.9	61.4	61.7	62.8	61.6	63.2	69.4	78.8	86.5	94.6	103.6	113.5	125.6	136.3
Kyrgyzstan	100	92.1	79.3	67.0	53.5	50.6	54.2	59.6	60.9	63.1	66.5	70.1	70.1	75.0	80.2	79.7	82.2	88.9
Moldova	100	82.5	58.6	57.9	40.0	39.4	37.1	37.7	35.3	34.1	34.8	36.9	39.8	42.4	45.6	48.8	50.8	52.4*
Russia	100	95.0	81.2	74.2	64.7	62.1	59.9	60.7	57.5	61.2	67.3	70.7	74.0	79.4	85.1	90.6	97.3	105.2
Tajikistan	100	100.0	100.0	83.7	65.9	57.7	48.1	48.9	51.5	53.4	57.8	63.4	70.2	77.9	86.2	92.0	98.4	106.1
Uzbekistan	100	99.5	88.5	86.4	81.9	81.2	82.6	86.9	90.6	94.5	98.1	102.2	106.3	111.0	119.5	127.9	137.2	150.7*
Ukraine	100	91.3	82.3	70.6	54.4	47.8	43.0	41.7	40.9	40.8	43.2	47.2	49.7	54.4	61.0	62.6	67.1	72.0

Source: Author's calculations based on CIS STAT database
**January through September*

1.2. Oil and Gas

In 2007 Kazakhstan was the second largest oil exporter in the FSU after Russia. According to the BP Statistical Review of World Energy 2008 (BPSR08) by the end of 2007, proven oil reserves of Kazakhstan amounted to 39.8 billion barrels. To put this amount into perspective, it is more than in Nigeria (36.2 bn bbl), US (29.4 bn bbl), Canada (excluding oil sands 27.7 bn bbl) or Qatar (27.7 bn bbl). In other words, Kazakhstan possess's around 3.2 percent of the world's total proven oil reserves, while Russia, has about 6.4 percent of the total. Oil production has increased from 550 thousand bbl/day in the 1990 to approximately 1.5 million bbl/day in 2007, demonstrating a three fold rise compared to its 1990 level. Moreover, in its Strategy for Fuel and Energy Complex Development to 2015, Kazakhstan's Government envisages production to increase to approximately 2.5 million bbl/day by 2015, according to the low case scenario, and 3.6 million bbl/day according to the high case scenario.

A dramatic growth of the oil sector was preceded by vast FDI inflows. Kazakhstan, predominately its energy industry, has attracted about 75% of all FDI into Central Asia[1]. However nowadays, associated with a lesser dependence on foreign investors, the Government aims to play a more active role in developing the country's oil resources. In 2004, a mandatory requirement was introduced that the share of the state-owned oil and gas

[1] OTAC working paper – "Kazakhstan's Energy Sector Overview", 2004

company, KazMunaiGas, in new oil projects should be at least fifty percent. The results of increased government control over the country's natural resources are yet to be seen, but it may significantly reduce FDI inflows in the future, which in turn might have a negative spillover effect on the economy. While a windfall of oil revenues reduced Kazakhstan's need of cash flow that FDI brings, if the economy is to be competitive it still requires foreign technology and management expertise, which are also associated with an inflow of FDI.

Most of oil produced in Kazakhstan is intended for export. In 2007, Kazakhstan exported about 80 percent of all oil it produced. However, being a landlocked country Kazakhstan does not have a direct access to the international markets. There are several major routes for the export of Kazakh oil. Caspian Pipeline Consortium (CPC) is currently the most important one. It connects the largest oil deposit in the west of the country "Tengiz" with the Russian oil terminal in the Black Sea near Novorosiysk, from where oil can be delivered to the European markets. The project is a joint venture between seven countries including private companies. The start of its operation in 2001 significantly reduced Russian monopoly over transportation prices for Kazakh oil since it opened an alternative route to the Atyrau-Samara pipeline system. The latter provided an almost exclusive access of the Kazakh oil from port in Atyrau to the Black Sea via the Russian pipeline system. In 2006, Kazakhstan completed construction of a new pipeline to China, which diversified even more its export routes and increased pipeline capacity.

Natural gas is by far less important to Kazakhstan's economy compared to oil. Despite possessing extensive reserves of mainly associated natural gas, until recently Kazakhstan consumed almost as much as it produced. Nonetheless, starting in 2004 production exceeded consumption, and in 2007 it amounted to 27.3 Bcm of natural gas, while consumption was at 19.8 Bcm. The country's proven reserves of natural gas come to 67 trillion cubic feet, or approximately 1.9 trillion cubic meters, which gives Kazakhstan a 17th place in the world and a 3rd in the FSU after Russia and Turkmenistan[2]. Before 1999 most of the extracted gas had to be flared due to a lack of related infrastructure. In August 1999 though, the Government introduced amendments to the 1995 Law on Oil, imposing an

[2] Based on BP Statistical Review of world Energy database.

obligation on oil producers to utilize their associated gas. Kazakhstan plans to achieve full utilisation of the associated natural gas by the end of 2010.[3]

Natural gas is imported from Uzbekistan, Russia and Turkmenistan in decreasing volumes. In July 2002, Kazakhstan's KazMunaiGas and Russian's Gazprom created a joint venture – KazRosGas - that will increase Kazakhstan's export capacity in the country's north. At the same time due to a lack of distribution infrastructure and taking into account that most of the natural gas is produced in the northern or western regions and consumed in the south, the southern part of the country will continue to depend on gas imports from the Central Asian neighbours.

1.3. Economic Revival

Real economic revival started only in 1999 and, perhaps not surprisingly, coincided with the start of massive expansion of the oil industry. Since 2000, has Kazakhstan enjoyed impressive rates of economic growth. In 2000-2007 real GDP growth averaged 10.2 percent, which made Kazakhstan's economy one of the most rapidly growing in the world. Over the same period fixed capital investments grew on average by 20 percent annually and unemployment has been declining steadily reaching 7.3 percent in 2007 (see Table 1.4). At the same time, real wages were rising and inflation fluctuated around 7 percent up until 2007, when it soared to 18 percent reflecting the world price hike on food and energy commodities. Strong macroeconomic performance was reinforced by the high prices on raw materials, notably oil and metals.

[3] According to the Environmental Control and Regulation agency (http://www.zakon.kz/our/news/news.asp?id=30365031)

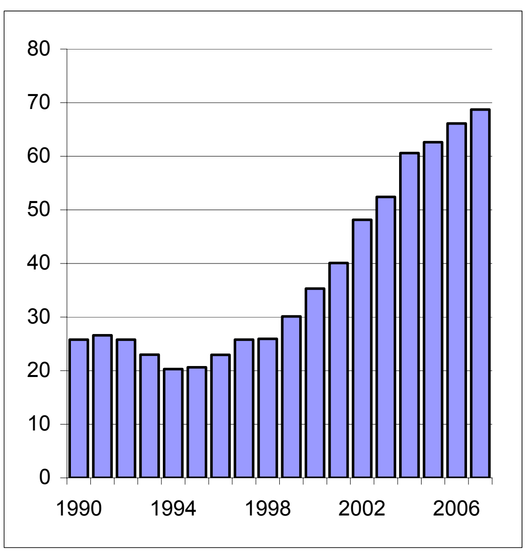
Table 1.4. Selected Macroeconomic Indicators

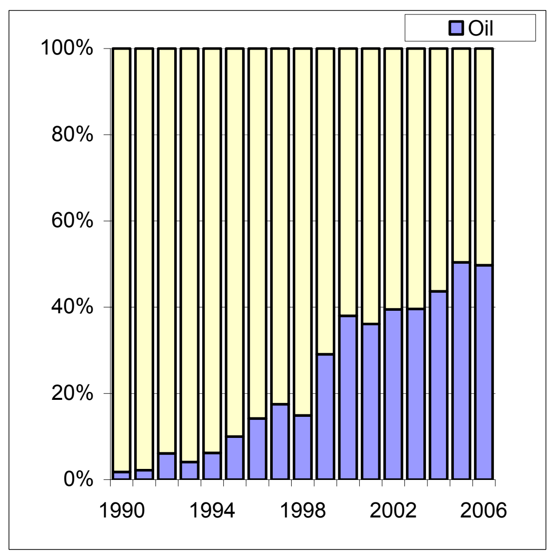
	2000	2001	2002	2003	2004	2005	2006	2007
Real GDP (% growth)	9.8	13.5	9.8	9.3	9.6	9.7	10.7	8.9
Nominal GDP (mln. USD)	18292	22152	24636	30833	43150	57124	81003	104853
Export (mln. USD)	8812	8639	9670	12927	20096	27849	38265	47755
Import (mln. USD)	5040	6446	6584	8409	12781	17352	23685	32756
CPI	109.8	106.4	106.6	106.8	106.7	107.5	108.4	118.8
Unemployment	12.8	10.4	9.3	8.8	8.4	8.1	7.8	7.3
Oil price (in 2007 USD)	35	29	29	33	42	58	67	72

Source: The Agency for Statistics of the Republic of Kazakhstan and BP SR 2008

The extraction of natural resources is now major economic activity. Total oil production has more than tripled since 1990. It represents more than 50 percent of total industrial output. A lion's share of FDI is directed to the extraction of minerals (approximately 50 percent in the recent years and significantly larger in the past). More than 80 percent of total produced oil in 2006 was exported. A lot of oil trade goes through offshore trading companies and transfer pricing is a problem for Kazakhstan.[4]

Figure 1.3. Oil Production in Million Tonnes and its Share in Total Industrial Output





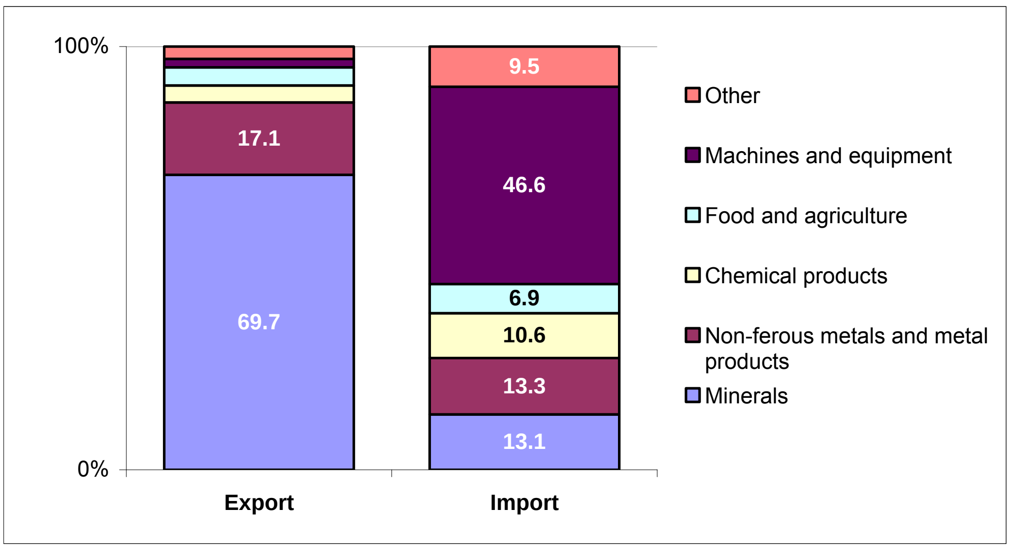
Source: Author's calculations based on ASRK statistics and BPSR2008

The trade pattern has also changed dramatically since 1990. In 2007, mineral resources accounted for 70 percent of the total export, whereas out of 69 percent in 2006 extraction of

[4] The issue of transfer pricing and ways to adjust national statistics so that it correctly represents the oil and gas industry is analyzed in Chapter 6 of this PhD thesis.

oil and gas was responsible for 64 percentage points.[5] Combined exports of mineral products and non-ferrous metals represent 87 percent of the total export amount. Moreover, in 2006, export revenues from the oil and gas sector only, amounted to 35 percent of GDP in 2006. At the same time value added share of all mining industry increased from 13 percent in 2000 to only 15.1 in 2007[6]. It is evident that the officially measured value added of the oil industry does not reflect its importance to Kazakhstan's economy.

Figure 1.4. Composition of Trade in 2007



Source: Agency for statistics of the RK

As the oil prices were rising rapidly, Kazakhstan's government became concerned with a potential negative impact of increased oil export revenues on other manufacturing industries and agriculture. Known as The Dutch Disease phenomenon, it represents a situation when a large windfall of export revenues from a booming sector drives up the real exchange rate, thus reducing competitiveness of other industries which produce tradable goods. It also increased the dependence of the Government's budget on the oil sector revenues. The economist Kanat Berentaev estimates the oil budget deficit to be no less than 7-8 percent of GDP and budget revenues from the oil sector comprise about a quarter

[5] Data for 2006 derived from Kazakhstan's Supply and Use tables.
[6] Author's calculations based on various official statistical sources

of the total budget revenues.[7] In August 2000 the Presidential decree established a National Fund. The primary objective of the fund is to protect the economy from the negative impact of the Dutch Disease and carrying out a stabilizing function in case of any adverse external economic shocks. It is also tasked with accumulation and redistribution of oil revenues among generations. The former Kazakhstan Finance Minister A. Dunaev suggested that in order to be able to perform its stabilization function the oil fund should be about 20 percent of GDP. According to the Ministry of Finance of the RK, as of December 2007, the value of the National Oil Fund amounted to 22 billion US dollars or approximately 21 percent of GDP in 2007. The national oil fund is a part of the budget system and regulated by the budget code.

1.4. Population Wellbeing[8]

Starting from 2001 an aggregate consumption has been growing faster than the GDP suggesting that general public also was able to enjoy some benefits of the booming economy. However with income inequality still being relatively high and with sizable percentage of population living below the official poverty line the question arises on whether the windfall benefits are equally distributed.

An analysis of a five year period household budget survey (each covering 12,000 individuals) can provide some indication of how welfare of the general population has been changing since the start of economic upturn. Table 1.5 demonstrates how expenditure of the representative household on selected items changed during 2001-2005. Note that the expenditure share of subsistence items such as food, electricity and heating, and other items has been falling steadily. Instead people spend more on personal goods such as communication, home appliances, and other.

[7] *www.krw.kz/netcat_files/File/on_national_fund.doc*
[8] This section uses the household budget survey data described in Chapter 4 of this thesis and also in Hare and Naumov (2008).

Table 1.5. Expenditure Structure of the Representative Household in 2001-2005

	2001	2002	2003	2004	2005
Food and Drink, Tobacco	51.7%	49.5%	46.9%	41.2%	39.8%
Clothes and Shoes	6.8%	7.2%	8.2%	9.6%	9.7%
Furniture, Textiles, Home appliances, Cleaning, Home products	4.3%	4.7%	4.9%	5.1%	5.4%
Personal goods, TV, computers, etc.	1.3%	1.5%	1.7%	2.0%	1.9%
Electricity, gas, heat and water, central heating	6.6%	6.5%	6.3%	6.3%	6.0%
Transport	2.9%	3.0%	3.2%	3.6%	3.7%
Post, Internet, Telecommunications	1.4%	1.5%	1.7%	2.2%	2.7%
Education	2.0%	2.4%	2.5%	3.2%	3.5%
Health and medical services	2.3%	2.3%	2.4%	2.5%	2.4%
Amusement and recreational services	0.5%	0.5%	0.6%	0.7%	0.7%
Inter-household transfers	2.6%	3.2%	3.6%	4.6%	5.2%

Source: Author's calculations based on KHBS data for 2001-2005
Note, components do not add up to 100% since some expenditure items have been suppressed for the ease of presentation.

The income share of social benefits has also fallen significantly from 22 percent of total income in 2001 to 16 percent in 2005, while percentage of income resulting from entrepreneurial activity increased from 9 to 17 percent in the same period. However, in 2002, the poorest 10 percent received only 3 percent of the total income and the richest 10 percent received about 27 percent, a pattern that also holds for other years of the sample.

Table 1.6 provides a poverty headcount index by region and type of settlement. There are two major mineral-producing regions in Kazakhstan, namely Atyrauskaya and Mangystauskaya, accounting for 42 and 24 percent of total minerals production in 2002. Interestingly, these two regions have the highest poverty level among all regions, which is primarily due to the rural poverty. The percentage of the poor declined for all regions over the period 2001-2005. However, the Atyrauskaya region, where most of the oil industry was concentrated in 2005, still had the highest rural as well as urban poverty headcount index. And that was following some years of high economic growth fuelled by oil production and the associated exports. This seems to be the case because Atyrauskaya along with the large chunk of oil revenues also has the second highest poverty line in Kazakhstan measured by the cost of the basket of basic goods and services. Five years of the energy fuelled economic growth helped to significantly reduce poverty in urban areas and while rural poverty also declined it remains nominally high. Taking into account that about half of the population in Kazakhstan live in rural areas it is clear that not everyone benefited equally from the economic upturn brought about by extraction of natural resources and high world oil prices.

Table 1.6. Poverty Headcount Index by Region and Type of Settlement

	2001		2002		2003		2004		2005	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Akmolinskaya	0.16	0.29	0.13	0.25	0.08	0.21	0.07	0.19	0.08	0.15
Aktubinskaya	0.14	0.26	0.07	0.26	0.03	0.19	0.03	0.14	0.03	0.16
Almatinskaya	0.23	0.29	0.16	0.28	0.05	0.22	0.04	0.10	0.05	0.10
Atyrauskaya*	0.19	0.31	0.19	0.35	0.13	0.20	0.13	0.31	0.10	0.24
West-Kazakhstanskaya	0.22	0.30	0.12	0.39	0.05	0.15	0.02	0.15	0.03	0.20
Jambilskaya	0.26	0.35	0.13	0.20	0.07	0.16	0.03	0.04	0.05	0.05
Karagandiskaya	0.18	0.24	0.10	0.15	0.06	0.23	0.04	0.23	0.03	0.15
Kostanayskaya	0.14	0.38	0.12	0.33	0.07	0.32	0.05	0.30	0.03	0.22
Kizilordinskaya	0.09	0.29	0.08	0.47	0.07	0.28	0.08	0.41	0.02	0.11
Mangystauskaya*	0.13	0.87	0.06	0.55	0.03	0.30	0.01	0.30	0.00	0.17
South-Kazakhstanskaya	0.13	0.26	0.06	0.16	0.06	0.14	0.05	0.11	0.04	0.09
Pavlodarskaya	0.10	0.26	0.07	0.38	0.03	0.15	0.03	0.17	0.02	0.14
North-Kazakhstanskaya	0.09	0.24	0.08	0.29	0.05	0.22	0.07	0.19	0.04	0.18
East-Kazakhstanskaya	0.15	0.30	0.12	0.26	0.10	0.25	0.07	0.29	0.04	0.21
Astana (city)	0.04		0.02		0.00		0.01		0.01	
Almaty (city)	0.05		0.02		0.01		0.01		0.01	
Kazakhstan	0.14	0.29	0.09	0.27	0.05	0.21	0.04	0.18	0.03	0.15

Source: Author's calculations based on KHBS data for 2001-2005
**Mineral rich regions*

Table 1.7 clearly demonstrates that there was no major change in average income inequality in this period, which suggests that poor and rich had a proportional increase in welfare.[9] However, regional inequality fell sharply in mineral-rich regions, whereas in most other regions it did not change at all or even experienced increase.[10]

Table 1.7. Entropy-Difference Income Inequality Indicators for Kazakhstan

	2001	2002	2003	2004	2005
GE(-1)	0.253	0.257	0.225	0.222	0.215
GE(0)	0.208	0.213	0.19	0.188	0.185
GE(1)	0.216	0.222	0.195	0.196	0.192
GE(2)	0.304	0.302	0.25	0.254	0.25
Gini	0.351	0.357	0.338	0.337	0.334

Source: Author's calculations based on KHBS data for 2001-2005

[9] The Gini coefficient measures average income inequality, with GE(*k*) being more sensitive to the top/bottom of the income distribution the more positive/negative *k* is.
[10] See for details Hare and Naumov (2008).

There is evidence that growth over the considered period has been strongly pro-poor, at least, to an extent. One of the questions in the household budget survey required respondents to estimate on the scale from 1 to 5 how satisfied they were with their monthly income. For example, a share of people who were totally unhappy about their income fell by 13 percentage points from 22 percent in 2001 to 9 percent in 2005. Correspondingly, share of those in the middle of the scale (who more or less can find a way out) increased by 15 percentage points in the same period, while those who were satisfied or fully satisfied, gained only about 3 percentage points (see Table 1.8 for details).

Table 1.8. Degree of Satisfaction With a Monthly Income (in percentage)

	2001	2002	2003	2004	2005
Not satisfied at all	22%	17%	13%	11%	9%
Not satisfied	38%	36%	35%	33%	32%
We can find a way out	32%	38%	42%	44%	47%
Satisfied	9%	9%	11%	12%	12%
Fully satisfied	0.4%	0.3%	0.3%	0.2%	0.3%

Source: Author's calculations based on KHBS data for 2001-2005

To summarise, we can argue that Kazakhstan's oil-driven strong economic performance in the 21st century helped to improve living standards for all population groups. Although perhaps not as much as would have been desired. The country's poverty headcount index fell from 20 to 7 percent over the 5 years. Nonetheless, a large portion of the population in rural areas still remained below the poverty line in 2005. Average incomes have been growing rapidly cutting the budget share of subsistence spending, at the same time income inequality remained high with the richest 10 percent of the sample receiving about 27 percent of income.

CHAPTER 2

Literature Review of CGE Applications

2.1. Introduction

The subject of computable or applied general equilibrium is an interesting and challenging one. On one hand, it requires quite an advanced knowledge of one of the most complex pieces of economics, notably general equilibrium theory. On the other, the skills of a good programmer and knowledge of specific software packages are essential to becoming proficient in the field. However, the result is truly remarkable and worth all efforts. The scope for the application of the models is wide-ranging and keeps expanding.

Even in the presence of heated theoretical debates the development of models were often driven by the need for a specific application rather than by the ideas of a particular school of thought. There have been relatively small changes to the main structure of the major computable general equilibrium technique, while incremental changes were enormous. This Chapter reviews some of the applications of computable general equilibrium models. Its specific concerns are applications to energy and transition economies, thus setting a background for Chapters 3 and 5 of this thesis, where building a small CGE model for Kazakhstan and some of its applications will be discussed. Rather than giving an exhaustive treatment this study looks into a wide range of topics each of which could be considered a small review on its own.

Thus, the first section provides the theoretical background for most of the empirical general equilibrium models. Section two deals with the development of computable general equilibrium models, touching on the main assumptional framework around which they are built. Section three addresses the energy and environmental applications and looks at issues such as energy taxation and the impact of higher energy prices. In section four, the economies in transition will be looked at and some applications to transition specific questions will be discussed. Models of Kazakhstan's economy will be considered in section five. Finally, section six will conclude by looking at the policy impact of applied general equilibrium models. Some of the models considered in this review are concisely described in the table B.1 of the Appendix B.

2.1. Theoretical background

The modern paradigm of general equilibrium has a longstanding history of development. Many seminal studies, dating back to as early as the 18^{th} century, played their essential role in shaping the theory until Arrow and Debreu finally formalised the concept and rigorously proved the existence of equilibrium in the economy where agents make independent decisions. In the competitive Arrow-Debreu equilibrium, demand and supply decisions depend only on the relative prices.

Herein the basic theoretical foundation for what has become known as "computable general equilibrium" or "applied general equilibrium" (CGE or AGE accordingly) will be briefly outline based on Debreu (1959) and Arrow and Hahn (1971).

An Arrow-Debreu economy is of decentralised nature, considered at a given instant and characterised by commodities, initial resources, consumers and producers. Commodities are distinguished by their physical properties, time of availability and location where it will be available. Every commodity has a price, a real number, expressed in some arbitrary unit of account. This allows for distinguishing between three types of commodities namely scarce (positive price), free (the price is zero) and noxious commodity (negative price). Without loss of generality, it is possible to consider only nonnegative prices, due to assumptions used in the proof of existence of equilibrium. Moreover, it can be shown that such a set of equilibrium prices will be strictly positive. The economy is perfectly competitive meaning that each economic agent considers himself insignificant in affecting the prices with his actions.

The number of producers and consumers is finite**.** They choose production/consumption plans, which formally can be represented by a vector from $\mathbf{R}^l$ space, where l is the number of commodities. Producers at any given instant choose a production plan so as to maximise profit subject to the technological constraints, prevailing at that time, and treat prices as given. Summing over all production plans we get a total supply/output in the economy.

Consumers are characterised by their preferences and resources available to them. Every consumer chooses "the most preferred" consumption plan, which satisfies his wealth constraints as well as certain a priori constraints. Inputs in a household's consumption plan are various goods and services and his only output is labour. Summing over consumption for each consumer we get the total demand in the economy.

The crucial assumption on consumption and production sets is that they should be convex. In the producers' case, this assumption rules out the possibility of increasing return to scale. Convexity plays an essential role in proving the existence of general equilibrium. Convexity is a part of a set of sufficient conditions for the existence of general equilibrium, but it is not necessary. With some modifications to the model it is possible to relax this assumption, which is important to be able to do when considering for example monopolistic behaviour.

Total resources can be represented by the point from $\mathbf{R}^l$ space and are given a priori. The economy is characterised by private ownership, that is consumers own the resources and receive all revenues from production. This property is essential as it provides for the Walras's Law[11] to hold. However, it is possible to construct a GE model in a way that equilibrium would be achieved even without the model satisfying the Walras's Law (see for example Malinvaud, 1977). Another important concept introduced by Walras was the excess demand function, in our case it is the difference between total demand and the sum of total resources and total supply, at a given price vector.

Given the economy as above the mathematical problem of proving the existence of equilibrium reduces to finding a set of prices p, which would make corresponding excess demand zero for every commodity. The problem was solved by the joint effort of Arrow and Debreu in 1954 with the help of Brouwer's and Kakutani fixed point theorems, where

[11] Walras's Law - At any prevailing prices (in or out of equilibrium) the market demand is equal to the market supply, in other words, excess demand in the economy is zero. This implies that if supply equal demand in any n-1 markets, the same should be true for the remaining n-th market.

the latter is a generalization of Brouwer's result extending it from continuous functions to upper semi-continuous correspondences. It is possible to prove that under certain assumptions competitive equilibrium will be Pareto efficient, the converse will also be true although under different and more restrictive assumptions.[12]

Later research concentrated on the issues of stability and uniqueness of the competitive equilibrium as well on implications of dynamics. Of particular interest is the work of Scarf (1967), who designed an algorithm for computing a fixed point. Due to the lack of computational ability in that time it was a rather daunting task. The algorithm also provided the alternative proof of both Brower and Kakutani's fixed point theorems. Shoven and Whalley (1973) using a slightly modified version of Scarf's algorithm proved the existence of the general equilibrium solution in the presence of ad valorem producer and consumer taxes. It was an important step for the development of empirical applications of the GE theory. If the theory were ever to be applied it had to be able to reflect the realities of real economies, where taxes and therefore governments play an indispensable role.

Shoven in 1974 offered a more formal treatment of this issue by including taxes and government into the Arrow-Debreu framework. The government in his setting plays no role other than collecting taxes and distributing revenues. The difference from the classic Arrow-Debreu GE model is that now consumer demands and incomes depend not only on prices, but on demand and supply decisions of other consumers and producers in the economy. Using the author's notation, the government's revenue or tax collection R is treated as another good and the price vector was augmented by R. Shoven showed that even in the presence of taxes, the behaviour of economic agents satisfy the necessary conditions for an Arrow-Debreu equilibrium hence, the standard proof readily applies. He also made some generalisations towards multi-tier government structures and international tariffs. In this case, the price system is augmented by the k different tax revenues, each is treated as a similar good but in different location. Consumers are subject to a set of tax rates part of which could be called tariffs. As before, he shows that the augmented model satisfies the Arrow-Debreu assumptions and the existence proof follows.

[12] See First and Second Welfare Theorems for detailed exposition of the issue.

The computational general equilibrium model of international trade is also demonstrated by Shoven and Whalley (1974), which provides an alternative proof of existence of a competitive equilibrium with international markets with tariffs. In their formulation, all commodities differ by the country of origin and physical characteristics. Tariffs in this setting are paid by the consumers and generally represent the difference between the purchaser and producer price of a commodity. The government only has a redistributive role. It collects tariff revenues and distributes it among consumers of its own country, hence consumer demand for commodities depend on gross prices (including tariffs for foreign produced goods) and distribution of tariff revenues. Assuming that the endowment of goods can be owned domestically as well as not, in equilibrium the value of net imports is equal to the value of net ownership of the resources. Once again, the competitive equilibrium solution for this model is obtained using Scarf's algorithm.

One close concept of equilibrium - the Core is due to Edgeworth. In the Edgeworth exchange economy the Core represents a set of allocations or equilibrium states, where no agent or coalition of agents can improve themselves without making at least one agent worse off. As the number of agents in the exchange economy approaches infinity the Core approaches the Arrow-Debreu competitive equilibrium. This result has one important implication that is; it has demonstrated that under appropriate assumptions, such as convexity and no market externalities, the competitive equilibrium is robust (Arrow and Hahn, 1971). Hahn (1973) considers the Core to be the concept of social equilibrium as there is no reason, he asserts, for a coalition of agents to take the interests of others into account when there is a feasible opportunity to improve themselves.

General Equilibrium theory has become one of the pillar stones of economic science and benefited from contributions of some of the best scholars in the field. It is difficult to overemphasize its importance, quoting Hahn (1973, pp. 33):

> "The notion that a social system moved by independent actions in pursuit of different values is consistent with a final coherent state of balance and one in which the outcomes may be quite different from that intended by the agents is surely the

> most important contribution that economic thought has made to the general understanding of social processes."

2.3. Development of CGE

> "The multisector CGE model provides a versatile empirical simulation laboratory for analyzing quantitatively the effects of economic policies and external shocks on the domestic economy". - Robinson *et al*. (1999)

The development of applied general equilibrium analysis has been accompanied by an ongoing debate over which school of economic thought should prevail in the construction of "real-world" CGE models. Two notable fronts are "neoclassical" and "structuralist" models.

Neoclassical models assume optimising behaviour and full employment of the production factors. It dates back to Walras and his assumptions. Households are assumed to own the primary resources and to spend all of their income on purchases of goods and services. The assumption of private ownership of primary factors ensures the fulfilment of the income-expenditure balance, in other words total value of goods and services demanded will be always equal to the total value supplied. In the words of Robinson (2003, p.9) the philosophy of this school is stated as "There is only one model and its prophet is Walras". A solution to early neoclassical models, Scarf and Shoven (1983) and Shoven and Whalley (1984), was obtained by finding fixed points using Scarf's algorithm (Taylor, 1990). With the development of computational ability this approach was abandoned in favour of nonlinear equation solving procedures, which were endorsed by the structuralist modellers.

The structuralists' argument against neoclassical point of view could be briefly described as – this is not the world we live in. Supporters of the structuralist modelling school argue that structural characteristics such as unemployment, imperfect competition or financial mechanisms are fundamental to the behaviour of the economy. Accordingly, Taylor (1990, p.2) describe structuralism as "… more a program of research and policy formation than a well-defined set of rules for putting a model in place".

In practice, however this debate what closure rules to apply. The model is considered "closed", "…if all variables or unknowns can be calculated once certain policy variables are fixed and exogenous projections made" (Blitzer *et al*., 1975, p.8). Basically, the model's closure is an adjustment mechanism which is based on the scope of research and realities of the economy in question.[13]

Nowadays, the majority of CGE models attempt to take the best from both worlds – the elegant neoclassical foundation and practical structuralist features. Nevertheless, Walrasian general equilibrium paradigm lies in the foundation of most CGE models. Therefore, in the discussion that follows a number of standard assumptions upon which empirical models, grounded in the neoclassical Arrow-Debreu equilibrium theory will be examined. In references to these models words such as general or normally will be used extensively. Also, a number of important extensions such as imperfect competition and dynamics will be looked at in the context of mainstream applications.

It is widely accepted that a pioneer of Computable General Equilibrium modelling was Leif Johansen (the influential study is Johansen, 1960). His 22-sector neoclassical model of Norway was a pioneering extension to the input-output framework and allowed for price changes and substitution in production and consumption. The general structure of his model has been adopted by many researchers in the field in later years. Some of the major assumptions that he employed are as follows: factors (labour and capital) are substitutes in the C-D production function; intermediate demand is Leontief's fixed coefficients function; household consumption, government consumption and investment levels depend on the relative prices with fixed shares for final products; fixed aggregate investment with varying savings rate; full employment of production factors, which are perfectly mobile across sectors. However, as pointed out by Goldberger (1961), treatment of foreign trade was the least thorough. Imports and exports determined exogenously (using fixed production coefficients); in addition imports are split into competitive and non-competitive, which are further divided into imports of consumption and production goods. The complete model is

[13] Whalley and Yeung (1884) review different external sector treatments and closure rules. Robinson (2003) discusses the issue of macro-closure in detail.

a system of 86 equations, linear in growth rates and derived by log differentiating of the highly non-linear Walrasian system. The resulting linearisation reflected the computational capacity at the time. In matrix notation, it can be solved using standard matrix algebra. Johansen's seminal study had made a significant contribution to the empirical literature on policy evaluation and determinants of economic growth.

A more comprehensive representation of the foreign trade, where domestic production and imports of similar goods are substitutes in the CES function, was offered by Armington (1969), which had shortly become standard assumption in CGE models. Armington's treatment of foreign trade implied imperfect substitutability between commodities produced in different countries. Before that trade was generally modelled as net or one way; that is a country could either be exporting or importing a particular commodity. This treatment was based on the classical Heckscher-Ohlin model of competitive advantage based trade. However, in reality countries showed a tendency for simultaneous import and export of the same goods, which was reflected in the Armington model. Similar treatment applies to exports. According to Robinson (2003) Armington's representation of foreign trade was widely recognised as an extension of the Salter-Swan model, which ended the debate on whether it was consistent with the neoclassical trade theory.

In most models all prices are relative and expressed in terms of one of the prices in a system called the numeraire. Depending on the macro closure, common choices for the numeraire are a GDP deflator, nominal exchange rate or the price index. These variables are usually readily available from the national statistics. In the neoclassical setting, volume indicators of a model are generally unaffected by the choice of the numeraire. However if some firms exhibit oligopolistic behaviour, the objective function of the producer will somewhat depend on the chosen normalisation. Nonetheless, Willenbockel (2005) points out that the numerical effect will be negligible if the overall share of an imperfectly competitive firm is small compared to the size of the economy. Despite this, deviation from the assumption of perfect competition and the constant return to scale had become quite profound in the applied literature.
Francois and Reinert (1997, pp. 19) indicate: "Failure to incorporate high-quality information on scale economies can lead to misleading policy simulations".

Harris (1984) showed that the presence of imperfect competition and economies of scale in the context of trade liberalisation significantly alters the results as compared with perfectly competitive case, in fact, the welfare gains could be as far as four times higher in the former. On the other hand, with restricted entry and exit, trade liberalisation can lead to an increase in unit cost and thus entail somewhat lower welfare gains than would be implied under perfect competition (Devarajan and Rodrik, 1989).

Normally, equations describing the behaviour of economic agents such as supply and demand functions are homogeneous of degree zero in prices. Doubling all prices in the model will have zero effect on the real variables and result in doubling of all nominal variables. Such money neutrality renders all nominal variables practically irrelevant for interpretation, something that is rarely discussed in the CGE literature. In the equilibrium state, models satisfy the Walras's law that is one equilibrium condition usually gets excluded, as the algebraic representation of a model generally is a system of nonlinear equations, which has to be square in order to have a unique solution. This means that when there are n equilibrium equations, if supply equal demand in any *n-1* markets, the same should be true for the remaining *n-th* market.

Models are usually supply-driven in the sense that the total supply of primary factors is fixed and equilibrium is achieved by adjustments of factor prices (e.g. wage or capital rental rate). It has become common however, to incorporate structuralist features such as unemployment and less than full capital utilisation (for example inventories). With such adjustments the model becomes more reactive to the demand-side shocks. For example the government could affect growth using fiscal policy, something that would not have a real effect if there was full employment of production factors.

Households' consumption behaviour is derived from maximising utility function subject to income constraint. By and large the Stone-Geary utility function is used for the households. It includes the Coub-Douglas functional form as a special case and has the so called subsistence consumption level, which households have to obtain before any other spending. Various transfers and social contributions, paid by households, are also often present in the models, but these are generally fixed in real terms and in most cases included to balance the accounts.

The government plays rather passive role with expenditure typically fixed in real terms and savings being residual item balancing the budget.

To balance savings and investments neoclassical closure has been used extensively in CGE applications. It assumes that savings by the government, households and the rest of the world are equal to total investments, which makes the model savings driven. Investments in a static, one-period model play only nominal role with no link between investment expenditure and capital accumulation. Moreover, investments are described by sector of origin rather than sector of destination. This means that the model does not show which goods, for example the construction industry uses as investment, rather it shows how much of the goods produced by construction was used for investment purposes. Another critique of static neoclassical CGE models refers to the logical inconsistency when consumers are making a lot of effort to optimise within-period decisions and suddenly stop doing it even for short time to the future (Devarajan and Go, 1998). In fact, many of the central questions which static models were designed to address may appear in a different perspective if considered in the dynamic environment. Static models generally concur that the real exchange rate would appreciate and consumption and investments will expand as result of favourable terms of trade shock. On the other hand a simple dynamic framework shows that consumption could actually decline initially to allow for increased investment and output, whereas real exchange rate in the long term might return to its base level after initial appreciation (Devarajan and Go, 1998). This suggests that dynamic models could provide some important insights into intertemporal behaviour of key variables. However it does not mean that dynamic models are unequivocally superior to static ones. Increased model complexity usually implies less detailed model structure. Dynamic models are built around an even stronger assumptional framework than its static counterparts. They have to incorporate assumptions about rates of economic growth, technology, population dynamics, interest rates etc. for decades into the future depending on the speed of model convergence.

2.4. Energy and environment CGE studies

CGE models can provide a rigorous analytical framework for the analysis of issues that have an economy-wide impact. The need for such a framework in analysing economy-energy-environmental interaction was felt strongly after the first oil shock in 1973. Following the Hudson and Jorgenson's (1974) pioneering study of US energy demand there have been a wide range of applications of CGE models to energy and environmental issues in the last three decades. Triggered by the first oil shock the CGE apparatus was called for to assist the analysis of various aspects of energy pricing, such as the structural adjustment of an economy in response to the energy price change and energy taxation.[14]

Borges and Goulder (1984) distinguished between three effects of higher energy prices in the United States: savings-investments effect, when higher prices reduce the return on capital thus slowing down the process of capital accumulation; terms of trade effect, in which the magnitude depends on the structure of foreign energy trade; and the direct effect, where energy prices directly increase the affects on the total factor productivity and on the degree of energy use in production of a particular good. Authors argue that since the current energy crisis may significantly reduce growth in the long run the use of a dynamic model could give a better insight. Consequently, in the reference case scenario constant growth rate was assumed over the entire period of 28 years in addition to perfectly elastic supply and constant oil price to reflect the case of no energy crisis. Out of all three effects the reduction in factor productivity alone, accounted for 50-84% of the total welfare loss. The savings effect was responsible for 15% of the total loss. The magnitude of the terms-of-trade effect crucially depended on the percentage of imports in energy consumption, and accounted for approximately 35% in the total welfare reduction.[15] However, one should be cautious interpreting their results, given that the time horizon of 28 years with the ad hoc

[14] For the detailed discussion of energy-economy-environment interaction in the context of CGE applications please refer to Bhattacharyya (1996), Conrad (2002) and Bohringer and Rutherford (2003).

[15] To control for the dynamic effect of savings and investments, savings were made to represent fixed share of household income rather than to be driven by return on capital as in the benchmark case. The terms-of-trade effect was controlled for by assuming that the imported oil is purchased at the cost of domestic production, thus making the difference between the market price and domestic production price to accrue to the capital owner in the home country rather than foreign producers. The importance of the direct effect was stressed by excluding both savings-investments effect and terms-of-trade effects.

assumption concerning economic growth involves significant levels of uncertainty at the termination point.

According to Doroodian and Boyd (2003) the oil price surge, that followed the first and second oil crisis (1973 and 1979 accordingly) has put a significant inflationary pressure on the US economy and coincided with the high level of unemployment. With the help of a recursively dynamic CGE model they investigated whether after 20 years the US had become more resilient to changes in the volatile oil prices. Indeed, since 1970s the US economy has become predominantly service-based and in the presence of strong economic growth and technological advances, an oil shock of the same magnitude as in the 1970s would cause much less disruption to the economy and would fade away completely in the longer run.

Although the issue of economic adjustment in response to the energy price change remains an important area where CGE models can effectively assist the analysis, it soon became dominated by the environmental applications of CGE models, in particular with connection to global warming and emissions of greenhouse gases. Environmental problems are receiving increasing attention throughout the world and there is a wide range of CGE studies addressing them. Usually capital, labour and energy are assumed to be substitutes in the nested production function. However, remarkably few authors have provided econometric foundations for their choice of the structure of the production function and substitution elasticities, in most cases, these functions are simply intelligent guesses and often just guesses.

Among them Kemfert and Welsch (2000), who explore the implementation of the carbon tax in Germany, to limit CO2 emissions to the 1990 level. They also econometrically estimate capital-labour-energy substitution elasticities and find the composite of capital and energy as one input and labour as another to have the best fit. The estimated elasticities are on average higher than those available from the literature, which significantly affect the macroeconomic outcome. Higher elasticities imply a lower tax rate and reverse the sign of the result for some components of GDP in cases where tax revenues are redistributed to households by means of lump-sum transfers. When tax revenues are used to reduce the labour cost (via wage subsidies), higher elasticities result in slower GDP growth than standard elasticities. This is because less tax revenue is available under the higher elasticities assumption.

After studying the impact of compliance with the EU Directive on SO2 and NOx emission limits for large combustion plants in Poland, Kiuila and Peszko (2006), suggest that the additional cost of emissions abatement is significantly smaller when the abatement cost of polluting sectors is considered as revenues for other industries, which provide the required abatement technology and services (modelled as transfers from polluting to abating sectors).

Moreover, Kumbaro˘glu (2003) shows that taxation of SO2 emissions (so as to satisfy European environmental regulation) could have positive impact on GDP. In Turkey, emissions arise mainly from imported fuel inputs, the introduction of sulphur emission tax shifts consumption of imported fuel towards domestically produced and stimulates less fuel intensive sectors. Although, the positive impact on GDP level must have been reinforced by the fact that the government redistributes all tax revenues in the form of government spending.

Constraining emissions undoubtedly benefits the environment, however due to associated costs it could be more favourable to economic growth than business-as-usual scenario (for example Kumbaro˘glu, 2003) only in particular cases. On the other hand, improvement in resource productivity (including energy) that is “doing more or the same with less” certainly boosts the economy, whereas the environmental impact is ambiguous. There is an ongoing debate in the energy literature on whether improved energy efficiency is partly offset by the increased energy consumption. This phenomenon is also known as the “rebound” effect. While increased energy efficiency does, at least initially, lower demand for energy in the sectors that are subject to this improvement, the increase in competitiveness due to lower output prices in fact stimulates the most energy intensive sectors of the economy. Thus, enhanced resource productivity may not be sufficient to achieve improvements in indicators such as energy intensity of GDP and left alone, could even damage the environment in the long run (this is known as a “backfire” effect). In order to achieve improvements in environmental quality it might be necessary to counteract the positive competitiveness effects that occur due to the fall in the price of output in energy intensive sectors. Hanley, Swales *et al*. (2005) using the UKENVI CGE model of the UK find evidence in favour of the rebound effect. The magnitude of the possible rebound effect in the UK was found to be around 40% meaning that 10% improvement in energy efficiency in the UK brings about only 6% of energy savings.

Previously discussed studies used so called "top-down" approach to CGE energy modelling. Models of this type do not take into account technological details of energy production, but instead focus on the economy-wide interactions and are best suited for the analysis of price-induced changes such as environmental and energy taxation, energy price shocks etc. Another group of energy-environment-economy CGE models are called "bottom-up" models. Due to their ability to incorporate changes in relative technology bottom-up energy CGE models address issues of energy efficiency standards, changes in technology and became increasingly popular in analysing the impacts of GHG emission and global warming (Bohringer and Rutherford, 2006).[16]

The MARKAL family of models, developed by the Energy Technology Systems Analysis Programme of the International Energy Agency is a good example. MARKAL is implemented in GAMS and has user-friendly Windows based shell, which makes it possible for other researchers and institutions either to contribute to model development or use it without special technical skills. There are more than 80 institutions in more than 40 countries using this tool (Seebregts *et al*., 2001). The model structure includes both consumption and production energy technologies at the highly disaggregated level. Seebregts *et al*. (2001) discuss several model implementations: Gielen *et al*. (2000) examine the least-cost solution of meeting emission reduction targets; Bahn *et al*. (1998) analyses instruments such as emission permits within the Kyoto framework; technology learning and the impact of R&D investigated in Barreto and Kypreos, (1999) and Seebregts *et al*. (2000).

[16] See also Bhattcharyya (1996) for more examples of the bottom-up models.

2.5. CGE applications to economies in transition

When an economist thinks about transition it probably concerns the misbalance of demand and supply, high level of unemployment, underutilisation of the production capacity and obsolete capital, which to a varying extent, were common to every economy undergoing transition. What he probably would not be thinking of is any kind of equilibrium notion in this setting and almost certainly not the notion of neoclassical equilibrium, where the exact opposite of all those attributes of the early transition process is assumed. However, a SAM is a good snapshot of the centrally planned economy, as supply and demand in planned economies were balanced using planning techniques such as Input-Output modelling and linear programming, which are also integral to general equilibrium models. Hence neoclassical CGE models could relatively adequately analyse the impact of changes before the start or during the early transition. Furthermore, it is possible to effectively conduct policy simulations in countries already in transition. For this, various structural adjustments need to be introduced to the neoclassical framework, some of which would be common to every country in transition, whereas others often highlight the country specific transition experience.

On the example of Hungary and Poland Braber *et al*. (1993) show how CGE modelling can be used to assist policymakers in choosing among different transition paths. The transformation of an economy from centrally planned to market oriented involves measures such as price liberalisation, release of the exchange rate and privatisation of state-owned enterprises. There is no consensus among the economists on what speed and to what degree the reforms should be implemented, rather the experience showed that different approaches could succeed in different countries. Braber *et al*. (1993) design a method to compare the responses of an economy under different price regimes to a common shock. To simulate the impact on centrally planned and market oriented economies the same policy simulations were applied to the two types of models: fixed priced SAM multiplier model and CGE model. Simulations showed what to a varying degree was observed in many countries after the beginning of transition, namely that before liberalising prices and exchange rate, a great deal of attention should have been given to agriculture and industry, which benefited most from the fixed price regime while construction and services perform better when prices are fully flexible. This result is the direct response to changes in terms of trade. The exchange rate appreciates under flexible price settings, this renders export oriented industries (in our case heavy industry and agriculture) less competitive and forces them to reduce production.

Before 1991 the so called "Eastern bloc" countries operated their foreign trade transactions in two currencies. The dollar was used to trade with the Western countries, whereas the so called transferable rouble dominated transactions with the East, largely within the Comecon – the former trade system of the Eastern bloc. The collapse of the Soviet Union inevitably led to the dissolution of the Comecon (as it was operating unsustainably) and hence restructuring of the trade pattern. Furthermore, it involved the conversion of all the rouble transactions into dollars. Using complementarily I-O and CGE approaches Zalai (1993) simulated the impact of these transformations. He demonstrated how a CGE approach can be effectively applied to economies in transition to simulate the effect of structural changes in response to price changes. The model he employed is called HUMUS. It was originally developed to replace simpler planning techniques such as input-output, linear programming etc. Due to its nature it embodied some peculiar features, which were not present elsewhere, such as "differentiating between eastern and western trade areas, allowing for non-equilibrium determination of factor and commodity prices, eastern export/import quantities".

Planned economies are generally supply side driven, whereas the transition process reversed the picture and made aggregate demand to play a more important role in the allocation of resources. Zalai (1998) argues that endogenous capital and labour supply would better reflect short-run consequences of swift changes in final demand. He does not provide any justification for this argument one of which could be the likelihood of limited intersectoral capital mobility. Along with other plausible macro closures in transition he names: fixed wages and real exchange rate, which are usually controlled by the state; fixed capital supply and no substitution between factors; and fixed consumption, or private savings, or investments level.

Wehrheim (2003) provides arguments in favour of different capital treatments. He argues that after the collapse of the Soviet Union a large share of the old capital became obsolete due to its rigidity and inability to move to more profitable sectors, which provides a rationale for the assumption of fixed sectoral capital stock. To reflect the fact that in Russia, the wage rate for official employment in the mid 1990s was still determined between the trade unions and major employers he fixed nominal wages and let the labour supply become fully mobile, thus letting demand for labour determine the employment levels. Should be noted that real wages in Russia fell sharply, allowing employment to be maintained. In Central Europe, where real wage fell less, employment fell more. Finally, to concentrate on the short-run adjustment effects the author used relatively low trade elasticities. He further applies his extended version of the 1-2-3 model (one country, two sectors, three goods) to explain the rather poor performance of Russia's agriculture and food industry during the transition. Wehrheim (2003) finds that neither the adverse terms of trade shock nor reduction of the capital stock could have caused such a dramatic output decline in Russia's agriculture after the collapse of the FSU.

Overall, the general equilibrium framework appears flexible enough for analysing the impacts of transition related factors and CGE models will continue to play their role in assisting policy makers to make decisions during the transition process.

2.6. CGE studies of Kazakhstan

Previous section suggests that transition aspects of an economy need to be embodied into the modelling framework if the model is to reflect the reality. With respect to Kazakhstan it would certainly be true for modelling any pre-1998 development. However, after 1998 Kazakhstan can arguably be considered as past the transition stage since most of the imbalances would have been removed. Privatisation was mostly completed all prices and wages were liberalised and most of the capital adjustment would have taken place reinforced by the Russian financial crisis of 1998. Therefore in the reviews that follow there are no references to the transition-specific features of modelling Kazakhstan's economy, but rather to the trade and development specifications.

There have been a very few CGE studies of Kazakhstan. To the author's best knowledge not a single study was published in a scientific journal. Some related work was conducted by the IMF and the World Bank, although these institutions tend to restrict their choice to standard models, which often could be quite general in terms of sectoral representation and not necessarily include features important to the economy in question. An interesting exception is the recent work of Jensen and Tarr (2006) on the impact of Kazakhstan's accession to the WTO. Kazakhstan has been in negotiations with the WTO since 1996, primarily trying to keep maximum protection for the export oriented agriculture. Jensen and Tarr built a 57 sector CGE model, which includes features such as barriers to foreign investment and local content requirement policy. The Dixit-Stiglitz framework, as an alternative to Armington CES, is employed for business services and imperfectly competitive sectors, for example the oil sector. Lower tariffs and reduced barriers provide for increased import variety in imperfectly competitive sectors which rises total factor productivity due to the Dixit-Stiglitz externality effect. The main result of their study is that the economy will gain about 3.7 percent of GDP in the medium term and up to 9.7 percent in the long run from WTO accession. Export-intensive sectors will gain due to improved access conditions to the foreign markets, while tariff-protected domestic industries which do a little exporting will likely to be the biggest losers. Decomposing these gains shows that a 50 percent discriminatory tax cut, applied to foreign services providers with the exception of water and air transportation (25 percent cut) and financial services (100 percent cut) is responsible for more than 70 percent of total gain from the WTO accession. The country already has practically free trade (or most favoured nation tariffs) with most of its neighbours and completed a great deal of liberalisation after gaining independence. Hence, a 50 percent reduction in all tariffs adds only 0.2 percent of GDP in terms of welfare gain. Improved market access for metal producers (export price up by 1-1.5 percent) implies increase in welfare by only 0.3 percent of GDP. Finally, the removal of local content requirement in the oil industry will likely to increase welfare by 0.5 percent of GDP.

A variation of the 1-2-3 CGE model was developed for the government of Kazakhstan in the framework of TACIS project in 1999.[17] Kazybaeva and Tanyeri-Abur, (2003) used this

[17] Calipel and Marchat, (1999) in Kazybaeva and Tanyeri-Abur, (2003). TACIS stands for Technical Assistance to Commonwealth of Independent States.

model, adding the food production sector, to analyze the impact of WTO accession on Kazakhstan's economy taking 1997 as a base year. Fifty percent tariff reductions in all sectors were considered in the first scenario. In the second scenario import substitution policy was modelled by doubling of all tariffs. The main finding of this paper is that the impact of trade liberalisation will probably be relatively small in Kazakhstan (about 0.3 percent of GDP) due to already low tariffs being in place. The welfare gain was not reported therefore it is difficult to compare this result against those in Jensen and Tarr (2006).

Without going into technical details of the model and data structure Khakimzhanov and Islyami, (2005, p.2) claim their model to be "…first CGE model of Kazakhstan with detailed division of sectors and more accurate tune-up of the model based on labour market data". However, this claim perhaps too strong, the model has only ten production sectors, it is static, has simple tax structure and the distinction is made only between urban and rural households. Other assumptions in the model are reasonably standard for generally neoclassical models with full employment and perfect competition. Various simulations were considered, such as taxation policy (5% increase on various taxes represented the range of taxation policy shocks), trade policy (the same scenarios as in Kazybaeva and Tanyeri-Abur, (2003)), and the impact of an increase in FDI etc. However, it is easy to lose track of the results and calculations in this study as in the case of taxation alone a total of 24 experiments were conducted.

One of the first applications to Kazakhstan was published by the IMF in 2003 (IMF, 2003). The model, originally developed by Dervis, Melo and Robinson, (1982) has 8 production sectors, only one of which represents cumulative petroleum industry. It bears pretty much standard assumptions about trade, production and consumption, but has one interesting extension. Stressing the importance of the oil sector for Kazakhstan's economy payments to foreign shareholders were directly linked to the oil revenues and increases in taxes from the oil sector (except product taxes) fully invested abroad, which somewhat accorded with the accumulation rules of the oil fund at that time. This study analyses the impact of a 10% increase in the price of oil under fixed and flexible exchange rates, and overall has a rather descriptive nature. The following year's IMF country report has a more interesting application of practically the same model (IMF, 2004). The model was used to analyse the impact of the Oil Boom in Kazakhstan by looking at several of its aspects. In this study two major ways to combat the potential adverse effects of the oil boom such as appreciation of the real exchange rate were considered. The first option is to restrain the appreciation of the real exchange rate through accumulation of the foreign reserves, trade barriers. However this option is fraught with the likelyhood of limiting investment and private consumption via savings accumulation. The second option is to allow the exchange rate to appreciate at the same time putting into action policies aimed to mitigate the adverse impact of the appreciation.

The oil boom in the study is associated with the increase in output of oil between 2000 and 2006 by 113%. This was implemented as an increase in the oil sector capital, which did not affect the capital available to other sectors. In addition, capital efficiency increases by 20% to reflect productivity gains in the oil sector.

The major findings of this work state that preventing the real exchange rate appreciation by limiting domestic absorption (consumption and investment) result in somewhat better performance of non-oil tradable sectors but overall economic performance is negatively affected. Imposing a 20% import tariff neither helps the non-oil tradable sectors nor does it limit the exchange rate appreciation. On the other hand, a 10% improvement in total factor productivity together with the oil boom boosts GDP by 20%. It also significantly limits the decline of the tradable sectors and exchange rate appreciation.

Both studies agree that in the longer run some real appreciation of the Tenge is inevitable and policies that aimed to restrain appreciation may prove to be counterproductive when done at the expense of domestic investment and private consumption, as opposed to policies aimed at total factor productivity improvement.

2.7. Influence on policy

> "Those who have numbers will win the debate against those lacking them. Again (ceteris paribus), those who have better numbers can expect to win." (Powell and Snape, 1992, pp.15)

The question remains however – how do we know whose numbers are best?

Australia was one of the first countries to use results of CGE analysis in policy debates. Notably ORANI general equilibrium model (developed by Dixon, Parmenter, Sutton and Vincent, 1982) was one of the major tools in hands of applied economists. At the present time governments in more than 20 countries have CGE modelling capacity at their service (Devarajan and Robinson, 2002). But if CGE apparatus can indeed effectively assist policy debates why only twenty? Three main reasons of why CGE based analysis become so widely accepted in Australia are provided by Powell and Snape (1992), these are: the availability of professional economists trained in CGE analysis; detailed and accessible documentation of the model, data and software; and the possibility of easily adapting the model to different applications. These conditions in place resulted in the number of CGE-based policy studies conducted by the various federal agencies in Australia rising from 1 in 1977 to 19 in 1990 (*ibid*).[18]

Yet, the widespread routine use of CGE models in the world become possible only after the emergence of special software packages such as GEMPAC and GAMS (and MPSGE) which were capable of solving complex models and gave users enough flexibility in modifying models to their needs.[19]

Perhaps the most relevant CGE models were in application to the trade policy debates. Devarajan and Robinson, (2002) draw on the NAFTA agreement as an excellent example where CGE models helped to shape the policy debate and effectively predicted the outcome. There was a general consensus among numerous CGE studies of NAFTA at that time that the large benefits of the agreement will be gained by Mexico and the impact on the US and Canada will be small although positive. Later research showed that this assessment was indeed correct.

[18] Most of these studies used some modification of the ORANI model.

[19] GEMPAC was developed in the Monash University in Australia by K. Pearson and G. Codsi in the late 1980[th]. GAMS originated in the World Bank and became standard tool for solving complex optimisation problems. MPSGE is the subprogram in GAMS developed specifically for CGE application by Tomas Rutherford.

However, there are also examples of "bad" CGE analysis and generally misleading estimates and conclusions based on such studies.[20] Ackerman (2006) points to at least four problematic assumptions in trade CGE models: "Armington elasticities" – bigger elasticities imply greater gains from trade liberalization; the results qualitatively differ depending on whether a country's net employment is fixed or not; a country's unchanged fiscal balance means that a loss of government tariff revenues have to be compensated by other means, such as changes in taxes in the case of the World Bank model, which is not a very realistic assumption according to Ackerman; finally, the results of dynamic models crucially depend on the assumptions about the future growth, which have to be developed outside the model, where "…only sky is the limit".

Current CGE models estimate much smaller gains from trade liberalisation than their predecessors. In the first place it concerns estimated benefits from the Doha round, which have shrank in the last few years. The World Bank study in 2002 estimated the benefits from the ambitious trade reforms for the global economy of around $800 billion, two-thirds of which were to be gained by the developing countries (2006, Subsidy Watch, Issue 2). Whereas more recent studies, such as the Carnegie Endowment study (ibid), suggest much smaller gains from trade liberalisation and almost negligible benefits for the developing world. Part of the reason for this lies in the complexity of CGE models and different assumptions and parameter values used by the modellers. Martin (2006) proposes that large benefits from the World Bank's study could stem from "… included potential productivity gains from increased participation in global trade".

CGE models are capable of capturing some distinctive features of the economy; they impose consistency between different markets and institutions and in good hands could provide a robust numerical foundation for policy makers. CGE-based analysis seems to influence policy debates most when results are supported by alternative modelling techniques and studies.

[20] Please see Devarajan and Robinson, (2002) for some examples.

CHAPTER 3

CGE Model for Kazakhstan

3.1. Introduction

This chapter will discuss the construction of a small Computable General Equilibrium model for Kazakhstan. The fundamental assumptions of the model are quite standard in the CGE literature. The model is static in the sense that no intertemporal decision making is involved. All industries are assumed to be perfectly competitive, meaning zero profit is earned by the firms. Small country assumption ensures that Kazakhstan is a price taker on the world market that is Kazakhstan's import and export decisions do not affect international prices. Finally, the model follows some of the Ecomod Modelling School conventions and belongs to the 1-2-3 class of CGE models.[21]

Employing these assumptions has several important implications for this study. Firstly, it facilitates the tractability of results. As pointed out by many authors (see for example Devarajan and Robinson, 2002) there is no use in the "black box" outcome and the transparency of results is essential. Secondly, the model as a whole is flexible enough to incorporate features specific to Kazakhstan's economy. In particular, the model is constructed to analyse the economy-wide impact of the booming oil industry in Kazakhstan in the recent years and it is believed to be appropriate to the task in its current formulation.[22]

The following notational conventions have been used throughout: real variables – upper case non-italic; nominal variables – upper case italic; parameters – lower case; indexes – lower case subscripts.

[21] See for example Robinson et al, (1999)
[22] For details please see Chapter 5.

3.2. Household

The basic version of the model assumes a single representative household.[23] This is a very restrictive assumption especially in relation to a country like Kazakhstan where the income gap between poor and rich is disproportionately large. This assumption will be relaxed in Chapter 5, where part of the emphasis will be placed directly on the income differentials and also discussed in the context of the SAM construction in Chapter 4. All equations will remain valid in the multi-household case, but an extra subscript will need to be added to some of them. According to the model, the household receives income from three sources. First, households supply labour and receive part of their income as wages. Second, it is assumed that firms are owned by households and households receive all profits from the firms. This link between firms and households originates from the theoretical proof existence of the general equilibrium as it guarantees the fulfilment of the Walras' law (see for example Debreu, 1959). Third, households receive transfers, such as social transfers and unemployment benefits from the government, and also remittances (transfers from the rest of the world). Hence, the total income received by households $Y,$ in a given time period (in our case year) can be represented as:

$$Y = Pk.\mathrm{KS} + Pl(\mathrm{LS} - \mathrm{Unemp}) + GHtrf + R.\mathrm{WHtrf} + CPI.\mathrm{HHtrf} \tag{3.1}$$

where KS and LS are the total capital and labour supplies, Unemp is the level of unemployment, $GHtrf$ represent transfers of unemployment benefits, WHtrf and HHtrf are remittances and inter-household transfers accordingly, and Pk and Pl stand for capital rental rate and nominal wage.

A household disposes of its income in the following way. He pays income tax $\mathrm{ty}.Y$ and social contribution HGtrf to the government and inter-household transfers HHtrf. He also transfers part of its income to the rest of the world HWtrf. In the case when all capital in the model is assumed to be owned by the households, this latter variable represents generic transfers, such as the return on foreign owned capital, income from foreign labour and other transfers abroad. A fixed portion of the remaining income is saved according to (3.2).

[23] Some of the modelling assumption used in this chapter will be modified in the later chapters to better reflect the essence of the analysed issues, hence the reference to the basic version of the model.

$$Sh = \text{mps}.(Y - \text{ty}.Y - R.\text{HWtrf} - CPI.\text{HGtrf} - CPI.\text{HHtrf}) \tag{3.2}$$

Where, mps is a marginal propensity to save parameter. Real social contribution HGtrf is fixed, however nominal amount varies with inflation. Since transfers to the rest of the world are expressed in foreign currency it is multiplied by the nominal exchange rate R. Therefore, the net income or household's budget available for consumption B is defined as

$$B = Y - \text{ty}.Y - Sh - R.\text{HWtrf} - CPI.\text{HGtrf} - CPI.\text{HHtrf} \tag{3.3}$$

The last remaining element of a household's spending is the final consumption. Cobb-Douglas form of Household's utility function has been used extensively in the CGE literature. It is a simple and easy solution since all necessary parameters can be directly derived using only the data from social accounting matrix. However, the assumption is not very realistic since income elasticity is equal to one, the own price elasticity is equal to minus one and cross price elasticities equal to zero. One possible generalisation of the C-D function is the Stone-Geary utility function (3.4), where the implied consumption demand is known as the Linear Expenditure System (3.7).[24]

$$\mathrm{U}\left(\mathrm{C}_1,\dots,\mathrm{C}_n\right) = \prod_{i=1}^{n}(\mathrm{C}_i - \mu_i)^{\alpha h_i} \tag{3.4}$$

The essence of this utility function is in the so called subsistence consumption level, which a household has to obtain before any other consumption. All remaining income is spent on consumption above that level, according to budget shares. Furthermore, if we assume that the subsistence level is equal to zero we get C-D utility function. The magnitude of the subsistence level can also determine to what extent consumption of a particular good is demand or supply side driven. Larger (smaller) shares make demand less (more) responsive to variations in prices or income. This property will be useful when we consider scenarios involving several household broken down by income levels.

[24] For details of derivation of LES and calibration of the parameters please see section C.3 of the Appendix C.

Thus, a household solves the problem of maximizing Stone-Geary utility function (3.4) by choosing consumption level C_i subject to budget constraint (3.6):

$$\max_{C_i} U(C_1,...,C_n) \tag{3.5}$$

Subject to

$$B=\sum_{i=1}^{n}(1+tc_i).P_i C_i \text{ , where } C_i > \mu_i \geq 0, \sum_{i=1}^{n}\alpha h_i = 1 \tag{3.6}$$

where tc_i is the tax on final consumption.

The solution to this problem determines household's consumption demand and is known as Linear Expenditure System (LES)

$$C_i = \mu_i + \frac{\alpha h_i (B - \sum_{j=1}^{n}(1+tc_j).P_j \mu_j)}{(1+tc_i).P_i} \tag{3.7}$$

Two sets of parameters need to be imposed from outside the model in order to calibrate parameters αh_i and μ_i: the so called Frisch parameter φ (expenditure elasticity of the marginal utility of expenditure); and household's income elasticity of demand for commodities *elasH*. Due to an apparent lack of econometric evidence on the locally relevant values of these parameters in Kazakhstan, the specific values had to be adopted from the relevant literature.[25]

3.3. Government

A government is assumed to maximize Cobb-Douglas utility function subject to budget constraints. It collects all taxes and social contributions, pays unemployment benefits, and saves a fixed amount of its revenues. Equation (3.8) defines the total government income as the sum of revenues from indirect taxes on final consumption tc_i, capital tax tk_i, taxes on intermediate consumption tic_i, import tariffs tm_i and export duties te_i, also revenues from personal income tax ty social contributions $HGtrf$ and transfers from abroad $WGtrf$.

[25] The main source for parameters is the CGE model for Kazakhstan built by Jensen and Tarr (2007).

$$GB = \sum_{i=1}^{n}\left(\mathrm{tc_i}.P_\mathrm{i}.\mathrm{C_i} + \mathrm{tk_i}.Pk.\mathrm{K_i} + \mathrm{tic_i}.\sum_{\mathrm{j=1}}^{\mathrm{n}} \mathrm{io_{ij}}.P_\mathrm{j}.\mathrm{Xt_i} \right) + \\ + \sum_{i=1}^{n}\left(\mathrm{tm_i}.R.Pmw_\mathrm{i}.\mathrm{M_i} + \mathrm{te_i}.R.Pe_\mathrm{i}.\mathrm{E_i} \right) + \mathrm{ty}.Y + \mathrm{C}PI.\mathrm{HGtrf} + R.\mathrm{WGtrf} \tag{3.8}$$

Equation (3.9) states that unemployment benefits, paid by the government, is a fraction hub, of the nominal wage:

$$GHtrf = \mathrm{hub}.Pl.\mathrm{Unemp} \tag{3.9}$$

The government's final demand Gi is assumed to be endogenous, whereas saving Sg is exogenous. Consequently, the government's demand for commodities derived from maximizing the Cobb-Douglas utility function (3.10) subject to budget constraints (3.11):

$$\max_{Gi} \prod_{i=1}^{n} \mathrm{G_i}^{\mathrm{\alpha g_i}} \tag{3.10}$$

Subject to

$$GB - GHtrf - CPI.\mathrm{Sg} - R.\mathrm{GWtrf} = \sum_{i=1}^{n} P_\mathrm{i}.\mathrm{G_i} \tag{3.11}$$

The left hand side of equation (3.11) represent the government's expenditure budget including the service of foreign debt GWtrf. From the f.o.c. we get the government's demand for commodities:

$$\mathrm{G_i} = \frac{\mathrm{\alpha g_i}(GB - GHtrf - CPI.\mathrm{Sg} - R.\mathrm{GWtrf})}{P_\mathrm{i}} \tag{3.12}$$

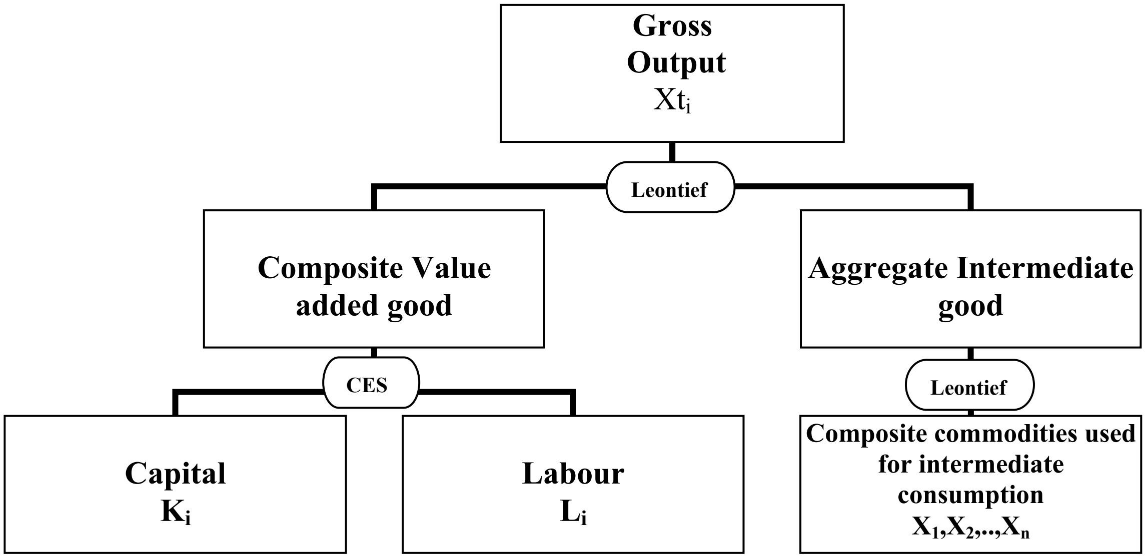
The conventional way to implement government behaviour in CGE models would be to assume fixed real expenditure, allowing the nominal expenditure to vary with inflation and savings to balance the government budget (negative savings meaning budget deficit, positive budget surplus). Although, the assumption of government maximizing a utility function may seem unrealistic it has several properties desirable for the Chapter 4. Such specification imposes fixed expenditure shares αg_i at the same time allowing expenditure to vary with income. That means for example, an increase in the oil revenue will result in the government raising its expenditure, which has been the case in many resource rich countries including Kazakhstan, and gives a further boost to the economy.

To complete the government specification we need to know values of parameters hub and αg_i. The later can be readily obtained from equation (3.12), as all other elements of the equation are known from the benchmark dataset, whereas the former has to be determined using additional sources of information.

3.4. Firms

Firms observe prices and make output decisions. They maximize profit subject to technology constraints. Every firm produces only one commodity according to the nested production structure using capital, labour and intermediates as inputs. At the lowest nest, Capital and Labour are combined into composite Value added goods using the CES function and Intermediates are combined into the aggregate intermediate good by means of the Leontief function. At the second nest, the producers' output is represented as a combination of composite Value added and aggregate Intermediates in the Leontief production function. Every intermediate good is the CES composite of domestically produced and imported commodities. The schematic production structure of a representative firm is shown on the diagram below.

Figure 3.1. Nested Production Structure of a Representative Firm



More formally, firm i chooses capital and labour by minimising the total cost of production, denoted as TC:

$$TC = (1+tk_i)Pk.K_i + Pl.L_i + (1+tic_i)\sum_{j=1}^{n} io_{ji}.P_j.Xt_i \tag{3.13}$$

Subject to technological constraint

$$Xt_i = af_i\left(\gamma f_i.K_i^{\frac{\sigma f_i-1}{\sigma f_i}} + (1-\gamma f_i)L_i^{\frac{\sigma f_i-1}{\sigma f_i}}\right)^{\frac{\sigma f_i}{\sigma f_i-1}} \tag{3.14}$$

where σf_i is the elasticity of substitution between labour and capital, af_i is the efficiency parameter and γf_i is the share parameter given that $\sum_{k=1}^{m}\gamma f_k = 1$. From the first order condition we get firms' labour and capital demand equations:[26]

$$L_i = \left(\frac{1-\gamma f_i}{Pl}\right)^{\sigma f_i}\left(\frac{Xt_i}{af_i}\right)\left(\gamma f_i^{\sigma f_i}[(1+tk_i)Pk]^{1-\sigma f_i} + (1-\gamma f_i)^{\sigma f_i} Pl^{1-\sigma f_i}\right)^{\frac{\sigma f_i}{1-\sigma f_i}} \tag{3.15}$$

[26] For details of the derivation of the demand equations of CES and parameters calibration see section C.4 of the Appendix C.

$$\mathrm{K_i} = \left(\frac{\gamma \mathrm{f_i}}{(1+\mathrm{tk_i})Pk} \right)^{\sigma \mathrm{f_i}} \left(\frac{\mathrm{Xt_i}}{\mathrm{af_i}} \right) \left(\gamma \mathrm{f_i}^{\sigma \mathrm{f_i}} ((1+\mathrm{tk_i})Pk)^{1\text{-}\sigma \mathrm{f_i}} + (1-\gamma \mathrm{f_i})^{\sigma \mathrm{f_i}} .Pl^{1\text{-}\sigma \mathrm{f_i}} \right)^{\frac{\sigma \mathrm{f_i}}{1\text{-}\sigma \mathrm{f_i}}} \qquad (3.16)$$

So far we have determined how firms choose production factors to produce a unit of its output in the most cost effective way; however, nothing has been said about how much output every firm should produce. It is assumed that firms choose their output level so as to maximize total profit. For the perfectly competitive economy and constant returns to scale production function (as is the case here) profit is equal to zero, hence instead of an explicit equation for output we use equation (3.17), which is also known as a firm's zero profit condition:

$$Pt_{\mathrm{i}}.\mathrm{Xt_i} = (1+\mathrm{tk_i})Pk.\mathrm{K_i} + Pl.\mathrm{L_i} + (1+\mathrm{tic_i})\sum\nolimits_{\mathrm{j=1}}^{\mathrm{n}} \mathrm{io_{ji}}.P_{\mathrm{j}}.\mathrm{Xt_i} \qquad (3.17)$$

3.5. Savings-Investments

The model is savings driven in the sense that aggregate investment equal total savings, which is the sum of individual savings components. This type of macroeconomic closure is known as "neoclassical closure" (Devarajan, Lewis, and Robinson, 1991). Equation (3.18) depicts total savings in the economy as the sum of private savings Sh defined by the fixed savings rate, government savings Sg determined exogenously and foreign savings Sf also determined exogenously in the basic model specification:

$$S = Sh + CPI.\mathrm{Sg} + R.\mathrm{Sf} \qquad (3.18)$$

Because the model is static, investments only play a nominal role, in other words, firms' investments decisions do not affect the amount of capital available for use in production. Therefore investment demand is modelled in the following way: investment demand in a sector i is a constant fraction $\alpha \mathrm{i_i}$ of the total savings S and it varies with commodity prices P_i. More rigorously, investment demand is derived by maximizing the utility function of an auxiliary agent:

$$\max_{Ii} \prod_{i=1}^{n} \mathrm{I}_{\mathrm{i}}^{\alpha \mathrm{i}_{\mathrm{i}}} \tag{3.19}$$

Subject to savings constraint

$$S = \sum_{i=1}^{n} P_{\mathrm{i}}.\mathrm{I}_{\mathrm{i}} \tag{3.20}$$

The solution to this optimisation problem will be the investment demand equations:

$$\mathrm{I}_{\mathrm{i}} = \frac{\alpha \mathrm{i}_{\mathrm{i}}.S}{P_{\mathrm{i}}} \tag{3.21}$$

Share parameters $\alpha \mathrm{i}_{\mathrm{i}}$ can be readily calibrated from the equation (3.21).

Perhaps it is worth reinforcing that the model is static in its nature and therefore investments playing only the accounting role. Even when we later allow for capital accumulation using the alternative capital closure rule discussed in section 3.7 and in Chapter 5, it is assumed that industries will be able to acquire capital directly avoiding investments at prevailing sector-specific capital prices.

3.6. Rest of the World (foreign sector)

The small country assumption implies that world prices are treated as exogenous, in other words, changes in Kazakhstan's import demand or export supply pattern do not have any impact on the world economy. Given this assumption, the domestic import and export prices can be represented as follows:

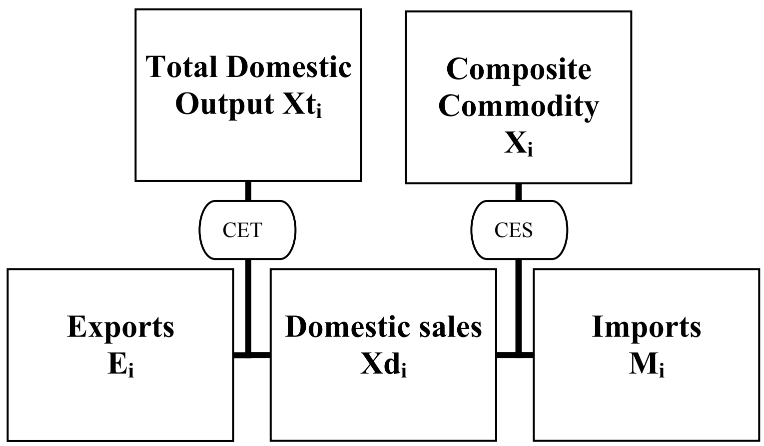
$$Pm_{\mathrm{i}} = (1 + \mathrm{tm}_{\mathrm{i}})R.Pmw_{\mathrm{i}} \tag{3.22}$$

$$Pe_{\mathrm{i}} = Pew_{\mathrm{i}}.R/(1 + \mathrm{te}_{\mathrm{i}}) \tag{3.23}$$

Where tm_{i} and te_{i} stand for import tariffs and export duties; Pe_{i} and Pd_{i} respectively, prices received by domestic producers for selling its output on the foreign or domestic markets; Pm_i represent domestic price of imported goods; Pmw_i and Pew_i are exogenous world imports and exports prices correspondingly; and R is the nominal exchange rate.

The treatment of exports and imports followed in this study was adopted in many CGE models. Armington's assumption ensures that imports and domestically produced goods are not perfect substitutes meaning that not all products can be produced domestically. Exports treated in the way that firms choose between selling output on the domestic market or exporting it depending on the relative prices and transformation elasticities. Such a setting allows for simultaneous export and import of the same good.

Figure 3.2. Schematic Representation of Export CET and Import CES Functions



Total domestic output Xt_i of a representative firm i is either sold on the domestic market Xd_i or exported E_i. The transformation takes place within CET (constant elasticity of transformation) function; therefore the optimal combination of exports and domestic sales of a particular good depends only on the relative (domestic to foreign) price of that good. To determine export and domestic production firms solve the following problem:[27]

Maximise total revenue

$$TR = Pe_i.E_i + Pd_i.Xd_i \tag{3.24}$$

[27] For details of derivations with CES/T function and parameters calibration see section C.4 of the Appendix C

Subject to the constant elasticity of transformation technology

$$Xt_i = ae_i\left(\gamma e_i.E_i^{\frac{\sigma e_i - 1}{\sigma e_i}} + (1-\gamma e_i)\,Xd_i^{\frac{\sigma e_i - 1}{\sigma e_i}}\right)^{\frac{\sigma e_i}{\sigma e_i - 1}} \tag{3.25}$$

Where ae_i, γe_i and σe_i are respectively, transformation efficiency parameter, CET distribution parameter and transformation elasticity.

The solution to this problem defines domestic and export sales of domestic output:

$$Xd_i = \left(\frac{1-\gamma e_i}{Pd_i}\right)^{\sigma e_i}\left(\frac{Xt_i}{ae_i}\right)\left(\gamma e_i^{\sigma e_i}.Pe_i^{1\text{-}\sigma e_i} + (1-\gamma e_i)^{\sigma e_i}\,Pd_i^{1\text{-}\sigma e_i}\right)^{\frac{\sigma e_i}{1\text{-}\sigma e_i}} \tag{3.26}$$

$$E_i = \left(\frac{\gamma e_i}{Pe_i}\right)^{\sigma e_i}\left(\frac{Xt_i}{ae_i}\right)\left(\gamma e_i^{\sigma e_i}.Pe_i^{1\text{-}\sigma e_i} + (1-\gamma e_i)^{\sigma e_i}\,Pd_i^{1\text{-}\sigma e_i}\right)^{\frac{\sigma e_i}{1\text{-}\sigma e_i}} \tag{3.27}$$

As is the case with firms' production in section 4, zero profit condition holds from which directly follows:

$$Pt_i.Xt_i = Pe_i.E_i + Pd_i.Xd_i \tag{3.28}$$

One way to look at the equation (3.28) is that, if both sides are divided by Xt_i, it defines the composite domestic output price Pt_i. Equations (3.24) and (3.28) are essentially the same conditions.

Imports are combined with domestic output in the CES function to produce composite commodity X_i. The optimal mix depends only on the relative prices. Demand for imports and locally produced goods, derived from minimising the total cost subject to CES technology constraint, thus the following optimization problem:

Minimize

$$\mathrm{TC} = Pm_{\mathrm{i}}.\mathrm{M_i} + Pd_{\mathrm{i}}.\mathrm{Xd_i} \tag{3.29}$$

Subject to

$$\mathrm{X_i} = \mathrm{am_i}\left(\gamma\mathrm{m_i}.\mathrm{M_i}^{\frac{\sigma\mathrm{m_i}-1}{\sigma\mathrm{m_i}}} + (1-\gamma\mathrm{m_i})\,\mathrm{Xd_i}^{\frac{\sigma\mathrm{m_i}-1}{\sigma\mathrm{m_i}}}\right)^{\frac{\sigma\mathrm{m_i}}{\sigma\mathrm{m_i}-1}} \tag{3.30}$$

Where $\mathrm{am_i}$, $\gamma\mathrm{m_i}$ and $\sigma\mathrm{m_i}$ are respectively, substitution efficiency parameter, CES distribution parameter and elasticity of substitution between imported and local goods.

From the f.o.c. we get the demands

$$\mathrm{Xd_i} = \left(\frac{1-\gamma\mathrm{m_i}}{Pd_{\mathrm{i}}}\right)^{\sigma\mathrm{m_i}}\left(\frac{\mathrm{X_i}}{\mathrm{am_i}}\right)\left(\gamma\mathrm{m_i}^{\sigma\mathrm{m_i}}.Pm_{\mathrm{i}}^{1-\sigma\mathrm{m_i}} + (1-\gamma\mathrm{m_i})^{\sigma\mathrm{m_i}}\,Pd_{\mathrm{i}}^{1-\sigma\mathrm{m_i}}\right)^{\frac{\sigma\mathrm{m_i}}{1-\sigma\mathrm{m_i}}} \tag{3.31}$$

$$\mathrm{M_i} = \left(\frac{\gamma\mathrm{m_i}}{Pm_{\mathrm{i}}}\right)^{\sigma\mathrm{m_i}}\left(\frac{\mathrm{X_i}}{\mathrm{am_i}}\right)\left(\gamma\mathrm{m_i}^{\sigma\mathrm{m_i}}.Pm_{\mathrm{i}}^{1-\sigma\mathrm{m_i}} + (1-\gamma\mathrm{m_i})^{\sigma\mathrm{m_i}}\,Pd_{\mathrm{i}}^{1-\sigma\mathrm{m_i}}\right)^{\frac{\sigma\mathrm{m_i}}{1-\sigma\mathrm{m_i}}} \tag{3.32}$$

Once again, the price of composite commodity P_{i} is defined using zero profit condition:

$$P_{\mathrm{i}}.\mathrm{X_i} = Pm_{\mathrm{i}}.\mathrm{M_i} + Pd_{\mathrm{i}}.\mathrm{Xd_i} \tag{3.33}$$

For completeness several parameters have to be imposed from outside the model, which will allow calibrating the rest (see section C.4 in the Appendix C for details of calibration of the CES/CET function). Specifically, assuming the negative (positive) values for the substitution elasticities' $\sigma\mathrm{e_i}$ ($\sigma\mathrm{m_i}$) we can derive $\mathrm{ae_i}$ and $\gamma\mathrm{e_i}$, ($\mathrm{am_i}$ and $\gamma\mathrm{m_i}$) . The CES/T functions are well behaved, namely if the elasticity of substitution is negative the function will be concave and if positive it will be convex. This property ensures that first order conditions for revenue maximization (cost minimisation) produce the desired maximum (minimum) solution.

The balance of payment equilibrium condition (3.34) concludes the description of the foreign sector. With foreign savings Sf and household transfers abroad HWtrf being fixed, equilibrium is achieved through the exchange rate variations, which adjust the levels of export and imports via the change of its relative prices (for detailed exposition of this matter see Robinson *et al.*, 1999).

$$\sum_{i=1}^{n} Pmw_i.\mathrm{M}_i + \mathrm{HWtrf} + \mathrm{GWtrf} = \sum_{i=1}^{n} Pew_i.\mathrm{E}_i + \mathrm{Sf} + \mathrm{WGtrf} + \mathrm{WHtrf} \qquad (3.34)$$

3.7. Production factors (Labour and Capital)

The core of the model is static therefore it is best suited for the short-run effect analysis as it does not incorporate inter-period capital adjustments through investment mechanisms or labour supply adjustments via e.g. migration flows. However some properties of the dynamic model, namely the long-run factors adjustment, can be incorporated in an ad hoc way, the amount of labour involved in production could vary with endogenous unemployment levels and total capital supply, although fixed in the basic model specification, could be made endogenously driven by demand. The model incorporates another long-run property, that is labour and capital are mobile across sectors.

It is assumed that all workers in the economy receive the same average wage PL. This, rather strong assumption could be relaxed by introducing the sectoral distortion parameters given the availability of data on the number of workers in each sector (see Robinson *et al.*, 1999 for details). Although total labour supply LS is fixed, the amount available for production could vary as workers move in and out of unemployment Unemp according to the wage curve relationship (3.35), is also known as the Phillips curve type of relationship.

$$\frac{\omega^1 - \omega^0}{\omega^0} = \rho \frac{u^1 - u^0}{u^0} \qquad (3.35)$$

Where

$$u = \mathrm{Unemp/LS};\ \omega = PL / CPI$$

The superscript 0 represent the benchmark equilibrium whereas 1 represent value after some change; CPI stands for consumer price index and ρ denotes the Phillips parameter, which has to be obtained from other sources. Assumption (3.35) along with fixed nominal wage (will be dealt with latter) implies that unemployment clears the market and hence defines the labour market to be demand driven.

For the price of capital, two specifications will be considered each corresponding to a different capital closure rule. In the basic model all sectors face an average capital rental rate Pk. Thus with fixed total capital supply the price is restricted by scarcity. Alternatively, the capital rental rate Pk_{i} could be sector specific and depend on the sectoral composition of capital goods. In other words, equation (3.36) reads that the capital rental rate in a sector i is a weighted average of the prices of composite commodities used by this sector as capital goods.

$$Pk_{\mathrm{i}} = \sum_{j=1}^{n} w_{\mathrm{ij}} P_{\mathrm{j}} \qquad (3.36)$$

Where

$$\sum_{j=1}^{n} w_{\mathrm{ij}} = 1$$

This representation of capital price is crucial for the simulation of the oil boom in Chapter 4, as it allows for sectoral capital accumulation to be demand driven given the endogenous total supply.[28] However, in the basic specification, total capital stock and labour supply are fixed exogenously, and factor markets clear according to equations (3.37) and (3.38):

$$\mathrm{LS} = \sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{L_i} + \mathrm{Unemp} \qquad (3.37)$$

$$\mathrm{KS} = \sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{K_i} \qquad (3.38)$$

[28] For details see Chapter 5.

3.8. Commodities' market clearing, CPI and balanced model

The last macroeconomic closure corresponds to commodities' market clearing equilibrium conditions. Equation (3.39) is somewhat intuitive and simply states that total domestic products supply (including imported goods) must equal total demand.

$$X_i = \sum_{j=1}^{n} io_{ij}.Xt_j + G_i + C_i + I_i \tag{3.39}$$

The consumer price index CPI helps to make nominal many of the variables in the model, it is of Laspeyres type and is defined as:

$$CPI^t = \frac{\sum_{i=1}^{n}(1+tc_i^t)P_i^t.C_i^0}{\sum_{i=1}^{n}(1+tc_i^0)P_i^0.C_i^0}, t = 0,1 \tag{3.40}$$

Equation (3.40) concludes the description of the small CGE model for Kazakhstan. The final model, as implemented in the software GAMS is concisely outlined in the section C.2 of the Appendix C. The algebraic form of the model is a system of nonlinear equations, solution to which is called the equilibrium state. For such a system to have a unique solution, the number of independent variables should be equal to the number of independent equations. To achieve this let us assume that $i = 1{:}n$, where n is number of sectors equal the number of commodities in the economy. After carefully counting all variables and equations we have:

NE = 15n + 11 - number of equations
NV = 15n +21 - number of variables

By fixing ten variables (GHtrfo, HWtrf, HGtrf, HHtrf, WHtrf, GWtrf, Sf, Sg, KS, LS) at their initial levels we get NV = NE. The exogeneity of some of these variables has already been discussed, others had to be made exogenous in real terms to balance the model, however nominally they can change. Furthermore, since the model satisfies Walras's law there is only 15n + 10 independent equations. By dropping one of the equilibrium conditions from the model (in this case it is the labour market clearing condition (3.37)), and fixing nominal wage Pl at its initial level (thus making it to be the numeraire) we again have the number of variables equal to the number of equations.

CHAPTER 4

Building a Social Accounting Matrix

4.1. Introduction

> "A SAM is an invaluable tool in bringing together whatever data there are and in helping to fashion a quantitative description of the initial position in an economy." (Pyatt and Round, 1985, p.13)

A Social Accounting Matrix (SAM) is a snapshot of the whole economy at a certain period of time. It contains information on domestic production, inter-industry transactions, transactions of institutional agents and operations with the rest of the world. There is practically no limit to the degree of detail in the SAM as long as appropriate data are available. Moreover, a SAM is much more than systematic representation of economic accounts. In the spirit of the Leontief's Input-Output models, it can be a valuable modelling tool capable of addressing various issues from the impact of reforms on the economic structure to the distribution of income among different household groups. However, construction of a SAM is not a trivial exercise. It often requires the pulling of data from many sources, which frequently contradict each other. Other data such as Input-Output tables and household surveys may be published only once in five years (as it is in the UK) due to difficulties and costs involved in collecting them.

In this chapter a SAM for Kazakhstan's economy will be constructed in four stages. First, an aggregated SAM will be compiled based on National Accounts and other sources. In this section all entries of the macro-SAM will be documented and their counterparts in the National Accounts and additional sources will be provided. The general form of description will allow for a similar SAM to be constructed easily for other years.[29]

[29] We provide numerical examples based on 2002 data, in addition, 2003 and 2005 are also constructed but not presented and available from the author on request.

Then, using Kazakhstan's Household Budget Survey, we disaggregate a single representative household by income based deciles and type of settlement (urban and rural).

National Accounts provide the base data for the construction of a macro-SAM. It contains almost all the necessary information, although in a highly aggregated form. Therefore, at the third stage, Input-Output (I-O) tables and household data will be reconciled with the macro-SAM using cross entropy and least squares methods of adjustment. At this stage the SAM will be balanced and all inconsistencies between different data sources will be smoothed out. The adjustment technique can also be used for updating the SAM, when parts of the data (often I-O tables) are not available for more recent years.

Finally, some of the detailed structure of the SAM has to be sacrificed in order for it to be consistent with the requirements of a CGE model for Kazakhstan. Accordingly, the necessary adjustments will be discussed.

4.2. SAM and I-O

The popularity of I-O tables lies in its ability to describe in sufficient detail intersectoral economic transactions, which take place during production processes in any given economy. Consider for example an oil industry, in order to produce oil they require inputs from many other industries in the economy. According to Kazakhstan's I-O classification, the oil sector is referred to largely as the exploration and production of oil. Whereas: pipeline transportation, extraction related construction etc., are recorded in the I-O table as inputs to the oil industry. Among other major industries supplying goods and services to the oil sector are financial services, power generation and distribution, railroad transportation and real estate services. Production also requires imports when some inputs can not be produced domestically for example. Finally, primary inputs such as capital and labour must be taken into account. In Figure 4.1, X_{ij} is referred to as intermediate inputs and Z_j as primary. Summing along the column all intermediate inputs into oil production together with primary inputs we get value of the total domestic output of oil. The sum of all primary inputs Z_j is equal to GDP of the economy.

Figure 4.1. Input-Output Framework

X_{11}	X_{12}	X_{13}	……	X_{1n}	Y_1
X_{21}	X_{22}	X_{23}	……	X_{2n}	Y_2
X_{31}	X_{32}	X_{33}	……	X_{3n}	Y_3
			………..		…
X_{n1}	X_{n2}	X_{n3}	……	X_{nn}	Y_n
Z_1	Z_2	Z_3	……	Z_n	

A similar principle applies if the elements of Figure 4.1 are considered along the rows. Output from the oil industry is used in the production of goods and services by other sectors, in this particular case mostly by the refinery industry and by the oil sector itself. It is also used in the components of final demand, defined as Y_i in Figure 4.1. Households may consume some oil for heating purposes, stocks could be accumulated, as commonly done by the governments for energy security reasons, and finally, a proportion of produced oil could be exported. The sum of all elements along the column of Figure 4.1 represents the total demand for oil. The sum of all elements of final demand Y_i is equal to the GDP.

A correctly constructed I-O table satisfies the basic accounting identity of equality between total supply and total demand (totals for the rows equal totals for the columns):

$$\sum_{i=1}^{n} X_{ij} + Z_j = \sum_{j=1}^{n} X_{ij} + Y_i \qquad (4.1)$$

The sum of final demand components Y_i and the sum of primary input components Z_j correspond to two methods of measuring the GDP – the final demand and the value added method accordingly.

The idea of having all inter-industry transactions in a neat table form was first documented by the French economist Francois Quesnay in his work “Tableau Economique” in 1758. This idea was developed much later into the consistent Input-Output framework by the Russian born economist Wassily Leontief. The first I-O table of the US economy was published in 1936 (United Nations, 1999). However, according to the same source, only in 1968 was it integrated with the system of national accounts by Richard Stone in the work “System of National Accounts, Studies in Methods”, published by the UN. This latter development allowed for systematic, large scale data collection, which, along with advances in computing facilities, shifted I-O methodology from a mostly academic realm to a highly applied tool used by governments and private institutions throughout the world. Since then, I-O has never been out fashion for its systematic and comprehensive treatment of the economy. Numerous studies have emerged extending the basic framework to address a wide range of issues such as energy and the environment, inter-regional development and dynamic considerations.[30] Sadoulet and deJanvry (1995) provide a discussion of the sources, methods, and applications of Input-Output analysis in developing countries.

Stone’s contribution to the development of economy-wide planning techniques also includes the construction of one the first SAMs in the early 1960s. The UK SAM was build within the work of the Cambridge Growth Project, initiated by Stone to analyse the industrial structure of the stagnating, at that time economy, of the United Kingdom (Pyatt and Round, 1985).

A SAM is often presented as an extension of the Input-Output framework by the inclusion of the income distribution accounts (who receives what and who pays who), lower right quadrant in the Figure 3.1. Indeed, I-O data are essential for building a disaggregated detailed SAM. But, in more general terms a standard SAM can be seen as an extension of the national accounts by the disaggregation of industrial production (via I-O tables) and by disaggregation of a representative household (via household surveys). This paper follows the latter interpretation in the construction of the SAM for Kazakhstan.

[30] See Miller and Blair, (1985) for good exposition of these and other I-O applications.

In practice a SAM is a square table, similar to the one in Figure 4.1, but has a much more detailed representation of the transactions of institutional units (see Table 4.1 for a descriptive presentation of the SAM for Kazakhstan). The idea behind a social accounting matrix is to present a double entry framework of national accounts in a matrix form, where each entry is recorded only once and represents at the same time receipt and expenditure. Columns in a SAM record expenditures and rows record receipts. A SAM requires that in each account total income equals total expenditure that is, total column sums must be equal total row sums. Unlike in the I-O table, the production account in the SAM consists of two parts – activities and commodities. The activities account represents transactions of the establishments and along the columns it is essentially value of domestic output as in I-O. Commodities on the other hand represent goods and services which are being produced or consumed and record total consumption or production of those products. Separate treatment of activities and commodities accounts allows for dealing with several problems arising from international trade. Domestic consumption is the composite of imported and domestically produced commodities, whereas only domestically produced goods are exported. Thus, the commodities account depicts the total consumption of composite goods, while in activities only domestic production is portrayed. Another advantage of this treatment is that it allows for a single activity to produce more than one commodity, which is often the case in reality.

4.3. Building a macro-SAM for Kazakhstan

This section will focus on how to build an aggregated Social Accounting Matrix (macro-SAM) and present the detailed description of its elements with sources of information required to build it. The Macro-SAM is largely based on the National Accounts statistics and references to cell entries refer to “Part 4. Integrated economic accounts of Kazakhstan” in the “National Accounts of the Republic of Kazakhstan 2001-2005” published by the Statistical Agency of Kazakhstan in 2007. Kazakhstan’s system of national accounts is based on the concept of the 1993 United Nations System of National Accounts. If an alternative source was used, such as household survey or government budget, it will be mentioned separately. Entries of the macro-SAM are described below by expenditure accounts, i.e. by columns of the SAM. The SAM as presented in the Table 4.1 has seventeen individual accounts:

Production includes – Commodities and Activities (Com and Act in the table);
Factors consist of – Capital and labour (K and L in the table);
Institutions include transactions of – Firms, Households and Government (F, H and G I in the table);
Taxes have – Taxes on final consumption, export duties, taxes on capital, taxes on intermediate consumption, import tariffs and direct taxes (TC, TE, TK, TI, TM, TY in the table correspondingly);
Investment (or capital account) – Investments/Savings and Inventories (I/S and Inven in the table)
Rest of the World group has only – Rest of the World account (R in the table);
Discrepancy – Statistical discrepancy (D in the table).

Table 4.1. Macro-SAM for Kazakhstan – accounts description

	Production		Factors		Institutions			Taxes						Investments		RoW	Discrepancy	
	Com	**Act**	**K**	**L**	**F**	**H**	**G**	**TC**	**TE**	**TK**	**TI**	**TM**	**TY**	**I**	**Inven**	**R**	**D**	**Total**
Com		Interm. demand				Final Cons.	Final Cons.							Fixed capital investments	Changes in inventories	Exports	Statistical discrepancy	**Final demand**
Act	Gross Output																	**Domestic output**
K		Capital																**Capital income**
L		Labour														Labour compens.		**Labour income**
F			Firm's Capital income		Inter-firm transfers	Transfers	Transfers									Transfers		**Firms' income**
H			Househ.'s capital income	Househ.'s labour income	Transfers	Inter-hous. transfers	Social benefits									Remitt.		**Househ. income**
G			Givern.'s capital income		Transfers	Social contribution	Inter-gov. transfers	Ind. taxes on final cons.	Export duties	Taxes on capital	Taxes on Interm. cons.	Import tariffs	Direct taxes			Transfers		**Govern. income**
TC	Ind. taxes on final cons.																	**Taxes on final c.**
TE	Export duties																	**Export duties**
TK		Taxes on capital																**Taxes on capital**
TI		Taxes on Interm. cons.																**Taxes on interm. cons.**
TM	Import tariffs																	**Import tariffs**
TY					Direct taxes	Direct taxes												**Direct taxes**
Sav					Corporate saving	Household's saving	Gov. saving									Current account balance		**Savings**
Inven														Changes in inventories				**Change In stocks**
R	Imports			Foreign labour income	Income To Rest of W	Transfers abroad	Transfers abroad											**Foreign currency outflow**
D														Statistical discrepancy				**Statistical discrep.**
Total	**Gross domestic supply**	**Gross domestic output**	**Capital expendit.**	**Labour expendit.**	**Firms' expenditure**	**Househ. expenditure**	**Govern. expenditure**	**Taxes on final cons.**	**Export duties**	**Taxes on capital**	**Taxes on interm. consum.**	**Import tarrifs**	**Direct taxes**	**Gross Investments**	**Change in stocks**	**Foreign currency inflow**	**Statistical discrepancy**	

4.3.1. Commodities

The commodities column and row in the SAM define resource-use identity and contain the value of all goods and services produced or imported. Along the column we have components of all available resources such as domestic output and imports. Along the row there is the use of these resources such as final consumption, export and investments.

Commodities - column:

Gross Output – entry (Activities; Commodities).

It represents the total value of goods and services produced in the economy in the corresponding period measured in basic prices.

In the National Accounts (NA) it corresponds to "Production/external account of goods and services" → "Output – Economy total".

Indirect taxes on final consumption – entry (Indirect taxes; Commodities).

This account is the sum of indirect taxes applied to the components of final demand except for export, which will have separate account. Rate of these taxes depends directly on the value of goods and services purchased. The examples include VAT, excise tax, sales tax, etc.

NA does not give a breakdown of indirect taxes by final and intermediate demands; therefore the number is taken from the 2003 I-O tables, (Table of taxes, row 69). There, it corresponds to the sum of taxes on household demand, government demand, demand of non-profit organisations and taxes on gross capital formation. In the NA import tariffs are also part of these taxes, therefore if import tariffs are reported separately it has to be subtracted from indirect taxes on final consumption.

Export duties – entry (Export duties; Commodities).

Taken from the I-O 2004, Table of Indirect Taxes, row 69 – indirect taxes on export.

Import tariffs – entry (Tariffs; Commodities).

Tariffs in the NA are part of the indirect taxes on final consumption and in the absence of better information we treat it as such. One could extract values of the tariffs by applying existing rates by product group to the total imports column. The total values of tariffs would then need to be subtracted from the total indirect taxes on final consumption.

Imports – entry (Rest of the World; Commodities).

Imports of goods and services are initially recorded in cost insurance freight (c.i.f) prices; however for the purpose of national accounts free on board (f.o.b) prices are used. Adjustment concerns transportation and insurance services rendered to get goods to the border of the importing country. These services would have already been included into import of services if rendered by foreign producers or output/export if rendered by domestic producers. The value of these services is usually subtracted from the value of corresponding transport and insurance accounts.

In the NA the correct reference is “Production/external account of goods and services” → “Imports of goods and services – Goods and services (uses)”.

4.3.2. Activities

The activities account defines gross domestic output in the economy. Along the column there are inputs to the production process, such as intermediate consumption and components of the value added. Reading along the column could tell you what share in the total value of a firm’s output attributed to, for example, labour input, thus giving an estimate of labour productivity. Along the activity row there is value of all domestically produced goods.

Activities – column:

Intermediate demand – entry (Commodities; Activities).

Intermediate demand signifies goods and services, which are totally consumed or transformed in the production process.

For the purpose of the SAM the intermediate demand should be expressed in basic prices, while NA reports it in consumer prices. Therefore, to convert it to basic prices: from the intermediate consumption account, as published in the NA, taxes on intermediate consumption should be subtracted (account (Indirect taxes; Commodities)) and subsidies should be added.

Corresponding to NA entries: “Production/external account of goods and services” → “Intermediate consumption – Economy total”; Table 1.18, p.25, “Transactions of institutional sectors” → “Subsidies on production and imports”.

Capital – entry (Capital; Activities).

Within the national accounts capital or operating surplus account, is usually calculated as a residual element by subtracting wages and taxes on production and import from the total value added. It consists of two elements: profit and consumption of fixed capital, where the latter is the same as capital depreciation.

The NA reference is the sum of “Generation of income account” → “Gross operating surplus – Economy total” and “Generation of income account” → “Gross mixed income – Economy total”.

Labour – entry (Labour; Activities).

This value comprised of total labour remuneration in cash or in kind, recorded in gross terms implying that various taxes and social contributions paid by households such income tax, are also included. Excluding labour income paid to residents from the rest of the world.

The NA reference is “Generation of income account” → “Compensation of employees – Economy total”.

Taxes on capital – entry (Capital taxes; Activities).

These taxes are paid by enterprises and include all taxes on production other than product taxes. Their rate does not depend on the value or volume of production. Among them are taxes on natural resources, land, licenses etc.

The corresponding reference in the NA is “Generation of income account” → “Other taxes less subsidies on production – Economy total”.

Indirect taxes on intermediate consumption – entry (Intermediate taxes; Activities).

Indirect taxes levied on enterprises for purchases of goods and services to use in the production process.

It is on the net basis and calculated as a residual after subtracting subsidies, export duties, import tariffs and final demand taxes from the total indirect taxes (“Generation of income account” → “Taxes less subsidies on products – Economy total”).

4.3.3. Capital

The capital account shows total profits in the economy gross of fixed capital consumption. Along the column there are the firm's gross profits and government's fixed capital consumption. Added together it comprises gross operating surplus and gross mixed income of the economy, which is the only entry along the capital row.

Capital – column:

Firms' capital income – entry (Firms; Capital).
It is an aggregated profit and capital consumption of corporations. Calculated using NA data as "Generation of income account" → "Gross operating surplus – Financial corporations + Non-financial corporations" plus "Generation of income account" → "Gross mixed income – Financial corporations + Non-financial corporations".

Household's capital income – entry (Household; Capital).
Represent household's mixed income and retained profit from enterprises.
In the NA it is "Generation of income account" → "Gross operating surplus – Households + NPISHs" plus "Generation of income account" → "Gross mixed income – Households + NPISHs".

Government's capital income – entry (Government; Capital).
Largely represent consumption of fixed capital by the general government.
The NA reference is "Generation of income account" → "Gross operating surplus – Government".

4.3.4. Labour

This account represents total labour remuneration paid/received by the residents including labour remuneration to/from the rest of the world. Along the column we have total payments to households and to the rest of the world. Along the row there are receipts of labour income as paid by the resident institutions and by the rest of the world.

Labour – column:

Household's labour income – account (Households; Labour).
Gross labour remuneration in cash or in kind received by the resident households.
The reference in the NA is "Allocation of primary income account" → "Compensation of employees – Economy total".

Foreign labour income – account (Rest of the world; Labour).
Gross labour remuneration in cash or in kind paid by the resident institutions to the rest of the world.
The NA reference is "Allocation of primary income account" → "Compensation of employees – Rest of the world".

4.3.5. Firms

The firms' accounts reflect operations of commercial enterprises. Along the row there is total income that is derived from profits and current transfers, along the column there is disposal of this income on savings taxes and transfers to institutional units. Firms, is a combined account for financial and non-financial enterprises, as originally reported in the national accounts.

Firms – column:

Inter-firm transfers – entry (Firms; Firms)
Inter-firm transfers defined exclusively by the property income. For details see the balance of transfers section.

Transfers to households – entry (Household; Firms)
This entry is the sum of two elements: change in net equity in households' pension funds and other current transfers, such as property income. For details on transfers see the balance of transfers section. The NA reference for the first part is "Use of income account" → Adjustment for change net equity of households in pension funds".

Transfers to government – entry (Government; Firms)

The entry is exclusively property income paid by the firms to the government. For details see the balance of transfers section.

Direct taxes – entry (Government; Firms)

Represent corporate income taxes as well as fines penalties and other current taxes.

The NA reference is “Secondary distribution of income account” → “Current taxes on income, wealth etc. – Financial corporations + Non-financial corporations”.

Corporate savings – entry (Savings; Firms)

Represent savings by enterprises, gross of fixed capital formation. Savings play the role of a balancing item for the use of income account. It is calculated as the difference between disposable income and final consumption expenditures.

Income to Rest of the World – entry (Rest of the World; Firms)

The entry corresponds to the property income. See the balance of transfers for details.

4.3.6. Household

The household account is a combined account of actual households and non-profit institutions serving households. The final consumption expenditure of the latter is provided free to households. Along the row there are sources of income for households such as wages, profits, pensions, etc. Disposal of income is stated along the household column and includes final consumption expenditure, saving and various transfers.

Household – column:

Household’s final demand – entry (Commodities; Household).

The household’s final demand includes purchases of all goods and services for final consumption. It is expressed in consumer prices.

Corresponding NA reference is “Use of income account” → “Final consumption expenditures – Household + NPISHs”.

Transfers to firms – entry (Firms; Household).

The entry is a sum of social contribution, property income and other current transfers. See the balance of transfers section for details.

Inter-household transfers – entry (Household; Household)

A small part of it is social benefits that NPISHs receive whereas the rest comes from other current transfers and corresponds to elements such as financial help between family members and relatives, etc. See the balance of transfers section for details.

Social contributions – entry (Government; Household)

Entry is the social contributions that households pay to the government. For details see the balance of transfers section.

Direct taxes – entry (Direct taxes; Household).

These are the taxes on the income and wealth of households. Income is defined as the net of taxes and transfers that is, income available for consumption and saving.

The NA reference is "Secondary distribution of income account" → "Current taxes on income, wealth etc. – Household".

Household's saving – entry (Savings; Household).

Represent saving by household, gross fixed capital consumption. The entry is the sum of saving by households and NPISHs. The negative value in the macro-SAM is due to NPISHs.

The NA reference is "Use of income account" → "Gross savings – Household + NPISHs".

4.3.7. Government

The government accounts represent operations of the general government, which include central and local governments. Along the row the government derives its income mostly from taxes. Government spending along the column consists of three major parts: provision of collective services such as government administration, health and defence; provision of actual goods and services to households; and transfers, paid mostly to households. The government also saves part of its income, which is usually a balancing item defining surplus or deficit of government's budget.

Government – column:

Government's final demand – entry (Commodities; Government).

The government's final demand expenditure besides actual consumption of goods and services for personal needs include spending on science, education, health and defence. As is the household's final demand, it is expressed in consumer prices.

NA reference is "Use of income account" → "Final consumption expenditures – Government".

Transfers to firms – entry (Firms; Government)

Transfers to firms defined by the property income payments. See the balance of transfers section for details.

Social benefits and other transfers – entry (Household; Government)

This entry is the sum of social benefits and other current transfers that government provides to households. For details see the balance of transfers section.

Government's savings – entry (Savings; Government).

Savings of the government, gross of fixed capital consumption, balance the state budget, with negative value for budget deficit and positive for surplus.

The NA reference is "Use of income account" → "Gross savings – Government".

Transfers to the Rest of the World – entry (Rest of the World – Government)

The entry corresponds to international government cooperation, such as payment for membership in international organisations, etc. See the balance of transfers section for details.

4.3.8. Taxes

There are six different types of taxes reflected in the current SAM. Indirect taxes include tax on final consumption, tax on intermediate consumption and other taxes on production. Taxes on foreign trade are comprised of import tariffs and export duties. Income tax is the only direct tax. All taxes are collected by the government.

Taxes – columns:

Indirect taxes on final consumption – entry (Government; Indirect taxes).
See the commodities-column for description.

Export duties – entry (Government; Export duties).
See the commodities-column for description.

Taxes on capital – entry (Government; Capital taxes).
See the activities-column for description.

Indirect taxes on intermediate consumption – entry (Government; Intermediate taxes).
See the activities-column for description.

Import tariffs – entry (Government; Tariffs).
See the commodities-column for description.

Direct taxes – entry (Government; Direct taxes).
See the household-column and firms-column for description.

4.3.9. Investments/Savings, Inventories

This account along the rows defines sources of financing investment and new capital such as private and public savings and transfers from abroad (foreign savings or current account surplus). Along the columns there are demands for investment goods and change in stocks, which when added together represent gross fixed capital formation.

Investments – column:

Fixed capital investments – entry (Commodities; Investments).

Represent consumption of mostly goods and construction services by resident units for investments purposes expressed in consumer prices.

In the NA, the correct reference is “Capital account” → “Gross fixed capital formation – Economy total”.

Changes in Inventories – entry (Commodities; Inventories).

Changes in inventories expressed in consumer prices and stand for accumulation or disposal of productive stocks.

The reference in the NA is “Capital account” → “Changes in inventories – Economy total”.

Statistical discrepancy – entry (Commodities; Discrepancy).

There is a statistical discrepancy between the Output method of measuring GDP and the Final Demand method. In the SAM it is a balancing item for the commodities account.

The actual value in the National accounts corresponds to “Capital account” → “Statistical discrepancy – Economy total”.

4.3.10. Rest of the World

All transactions with the rest of the world are included in this account. Rest of the world row defines total outflow of foreign currency and contain elements such as imports, factor income paid abroad and transfers abroad. Inflow of foreign currency is reported along the column and includes exports, various transfers from abroad and foreign savings (also represent balance of the current account).

Rest of the world – column:

Exports – entry (Commodities; Rest of the World).

Total exports of goods and services in f.o.b. prices.

Correspond to “Production/external account of goods and services” → “Export of goods and services – Rest of the world” in the NA.

Compensation of employees – entry (Labour; Rest of the world).
Represent compensation of employees from the rest of the world.
The reference in the NA is “Generation of income account” → “Compensation of employees – Rest of the world”.

Transfers to firms – entry (Firms; Rest of the World).
This transfer is exclusively a property income paid by the rest of the world to domestic firms. See balance of transfers section for details.

Remittances – entry (Household; Rest of the World).
See balance of transfers section for details.

Current account balance – entry (Savings; Rest of the world).
This account defines the current account balance. The positive entry represents surplus or foreign savings whereas negative would mean current account deficit represents investments abroad or net capital outflow.
The NA reference is “Use of income account” → “Current external balance – Rest of the world”.

4.3.11. Balance of transfers

Current transfers and direct taxes represent the difference between total income and disposable income or income available for consumption and savings. While there is no problem in dealing with direct taxes, transfers require much more attention and often estimation. According to Kazakhstan’s national accounts statistical breakdown current transfers consist of the following three elements: social contributions; social benefits other than social transfers in kind; other current transfers. Another element that is essentially treated as transfer is the property income. From the national accounts we know the total amount of each of these transfers that institutions receive and the total of what they pay. The problem is that we often do not know the breakdown of those totals, for example “other current transfers” that household receives could come from the firms or from the rest of the world or from both.

Transfers, direct taxes and property income together represent total transactions between institutions so that any inter-institutional transaction is one of these elements or a sum of several. Finally, there is an adjustment for change in net equity of households in pension funds, which is treated in the SAM as a transfer as well. Below there is a detailed specification of transfers for the year 2002.

Direct taxes are collected only by the government and paid by firms and households, therefore, it is easily dealt with.

The NA account is “Secondary distribution of income” → “Current taxes on income, wealth etc.”

Table 4.2. Income Tax

	Firms	Hous	Gov	RoW
Firms				
Hous				
Gov	182194	77474		
RoW				

Social contributions and **social benefits** are also can be readily allocated. The former paid by the households and collected by the government and firms. The latter is collected by households and paid by the firms and government. Thus, a breakdown can be derived.

NA references are “Secondary distribution of income” → “Social contributions”;

“Secondary distribution of income” → “Social benefits other than social transfers in kind”.

Table 4.3. Social Contributions

	Firms	Hous	Gov	RoW
Firms		48317		
Hous		149		
Gov		179793		
RoW				

Table 4.4. Social Benefits

	Firms	Hous	Gov	RoW
Firms				
Hous	26972	149	99297	
Gov				
RoW				

According to the NA (p.8) “**Property income** receivable or payable by institutional units in connection with the financial assets, land and other non-financial assets (minerals and other natural resources, patents, licenses, etc.) is at the disposal of other institutional units”. The detailed breakdown is unavailable from most additional sources, such as household surveys and government budgets, which also report only total receipts and payments. In order to allocate totals by their sources of origins and destinations we use additional assumption that property income is managed through the firms. In other words, we assume that, for example, the government does not engage in property dealings directly with households, but does it via enterprises. The assumption is very close to real situation as firms by far the main receiver and payer of property income, while total receipts and payment for all institutional units remain unchanged.

The NA reference is “Secondary distribution of income” → “Social contributions”.

Table 4.5. Property Income

	Firms	Hous	Gov	RoW
Firms	50408	35143	19226	36435
Hous	81289			
Gov	57492			
RoW	184188			

Other current transfers include: net non-life insurance premiums and insurance claims; inter-household transfers; inter-government transfers and international inter-government transfers; other transfers. To deal with these transfers we need information from additional sources. First, some transactions of domestic institutions with the rest of the world, namely remittances and international government cooperation payments, could be obtained from Kazakhstan’s balance of payment (“Statistical Yearbook of Kazakhstan – Statistical Compendium”, Statistical Agency of the Republic of Kazakhstan, 2006, p300.). However we will use only the latter number since there needs to be some residual elements to balance the table. Transfers of enterprises are predominantly those related to insurance premiums and claims therefore it is fully allocated between households and enterprises. In 2002 Kazakhstan’s Household Budget Survey inter-household transfers represent about 3% of total expenditure and approximately 5% if measured by income method. This is a significant amount and more than twice the number provided in the national accounts for total payments of other current transfers. Therefore, we allocate the total amount of these transfers to inter-household transfers cell, excluding only a small amount of transfers to firms as explained earlier. Finally to balance everything inter-governmental transfers, household remittances have been derived by balancing. A small residual has been allocated to household receipts from the government cell.

The reference in the NA is “Secondary distribution of income” → “Other current transfers”.

Table 4.6. Other Current Transfers

	Firms	Hous	Gov	RoW
Firms		5429		
Hous	7658	40377	3666	65257
Gov			48065	
RoW			47927	

The balance of transfers therefore is a consolidated table of tables 4.2 to 4.6, excluding direct taxes, which are treated separately.

Table 4.7. Consolidated Table of Transfers

	Firms	Hous	Gov	RoW
Firms	50408	88889	19226	36435
Hous	115919	40675	102963	65257
Gov	57492	179793	48065	
RoW	184188		47927	

Pension contributions and payments from/to pension funds are not treated as transfers in the national accounts, but as the acquisition and disposal of financial assets (unlike pensions which households received as part of social benefits). It represents the change in the net equity of households in pension funds. However this does not constitute a household's saving, therefore, the household's income has to be adjusted by adding this item as transfers from firms. We add this to the transfers from firms to households in the consolidated Table 4.7 and get the table of final transactions of institutional units. NA reference is "Use of income account" → "Adjustment for change net equity of households in pension funds".

Table 4.8. Total Transfers

	Firms	Hous	Gov	RoW
Firms	50408	88889	19226	36435
Hous	145882	40675	102963	65257
Gov	57492	179793	48065	0
RoW	184188	0	47927	0

Allocation of the transfers completes the construction of the macro-SAM for Kazakhstan. The example for 2002 is shown in the Table 4.9 below.

Table 4.9. 2002 Macro-SAM for Kazakhstan (in millions of Kazakh Tenge)

	Production		Factors		Institutions			Taxes						Investments		RoW	Discrepancy	
	Com	**Act**	**K**	**L**	**F**	**H**	**G**	**TC**	**TE**	**TK**	**TI**	**TM**	**TY**	**I**	**Inven**	**R**	**D**	**Total**
Com		3925515				2205940	434999							907126	123334	1781690	71150	**9449754**
Act	7542054																	**7542054**
K		1964842																**1964842**
L		1429195														595		**1429789**
F			1145140		50408	88889	19226									36435		**1340099**
H			780237	1418652	145882	40675	102963									65257		**2553666**
G			39465		57492	179793	48065	78690	81049	110459	112043	0	259668			0		**966724**
TC	78690																	**78690**
TE	81049																	**81049**
TK		110459																**110459**
TI		112043																**112043**
TM	0																	**0**
TY					182194	77474												**259668**
Sav					719935	-39106	313544									107236		**1101610**
Inven														123334				**123334**
R	1747961			11137	184188	0	47927											**1991213**
D														71150				**71150**
Total	**9449754**	**7542054**	**1964842**	**1429789**	**1340099**	**2553666**	**966724**	**78690**	**81049**	**110459**	**112043**	**0**	**259668**	**1101610**	**123334**	**1991213**	**71150**	

4.4. Disaggregating the household

Using the Kazakhstan Household Budget Survey for 2002 (KHBS02), we introduce several household types into the National Accounts based SAM presented above. The general idea is to take micro-level KHBS02 data, aggregate them according to the required level of household breakdown (e.g. urban/rural, or income deciles), scale them up to levels broadly consistent with the national level in the macro-SAM, and use some adjustment procedures to reconcile all the accounts in the SAM with their macro-aggregates from national accounts. Since a consistent macro-SAM has already been constructed, the information we need from KHBS02 is the composition of those aggregates by household types, while keeping the aggregates unchanged.

4.4.1. Household budget survey data

The Kazakhstan Household Budget Survey (KHBS) is a valuable source of information. The survey covers about twelve thousand individuals, the sample being designed to be representative at the regional level, and is compiled on a yearly basis. In 2001, a completely new methodology was introduced and this has been followed up to the present time. This means that from 2001 onwards the surveys are highly comparable across the years. However, successive annual surveys do not constitute a panel dataset, since no attempt is made to monitor the same individuals each year. The survey is in six parts:

1. Annual questionnaire, which includes housing conditions; availability of land, livestock and machinery; brief education and employment information.
2. Annual health module.
3. Annual expanded education module.
4. Annual household demographic card.
5. Quarterly questionnaire of the households' expenditures and income. It also includes quarterly employment statistics.
6. Quarterly diary of expenditures, filled in by respondents only for 14 days of the quarter in 2001-2003 and for 1 month in 2004-2005.

The raw primary household survey data come in dbf-format (i.e. Xbase or dBase datafile format) and are not at all organized in a user-friendly manner. It required considerable manipulation of the raw data to assemble a consistent time series of income and expenditure. The number of households taking part in the survey decreases every quarter, consequently, only data for those households taking part in all four quarterly interviews were used.

Household income is assembled using quarterly data from the following generic categories: transfers and other assistance; income from farming activity; income from own-production of goods and services; income from employment; and social benefits. For the purposes of the SAM construction we keep the income from sales of real estate, credit and borrowed money separate; these items need to be excluded from current income for consistency with the Kazakhstan National Statistical Agency (KNSA) methodology.

Total household expenditures consist of the following major blocks: diary items, which included food and drink and other non-food, frequently purchased goods; clothes, textiles and footwear; home appliances, furniture and other household goods; public utilities; education; health; transport; transfers and assistance; and other expenditures.

Since respondents filled in the diary only for 14 days in 2001-2003 and for 1 month in 2004-2005, to get quarterly expenditure we follow KNSA and multiply by 6.5 and 3 accordingly. Again, following KNSA and to avoid double counting, we do not include expenditures on farming activities and on own-production of goods and services (parts 9 and 10 of the quarterly questionnaire). The resulting file has about 600 expenditure items, which for presentation purposes and construction of the SAM we aggregate into 25 blocks.

4.4.2. Matching the SAM and Household Budget Survey Income and Expenditure

To disaggregate households by income deciles and type of settlement, we first need to match sections of the survey questionnaire with the household SAM accounts. The income account is relatively straightforward to match with the Household Budget Survey, since most of the entries, one way or another, are reflected in the survey questionnaire. The expenditure is much less clear cut, and needed to be dealt with in an ad hoc manner in places. Whenever we could not match a SAM category with the KHBS, we used the total level of that entry from the macro-SAM and broke it down by household types using shares from the closest available category.

Income_

Moving along the household income row:

Income from capital – entry (Household; Capital).
This entry is household's mixed income and retained profit. From the survey we include all entrepreneurial income and profits, such as income from sale of own production of goods and services etc.

Income from labour – entry (Household; Labour).
This is gross labour remuneration and corresponds to salaries and other payments for labour in the budget survey. We should note that the survey only collected data for net salaries or take home income. We have to use second best approach, namely use net labour remuneration from KHBS.

Income from transfers (firms to households) – entry (Household; Firms).
Since this entry mostly represents property income, from the household survey we include: dividends from shares, sale of personal property or real estate, and loans.

Income from transfers (inter-household transfers) – entry (Household; Household).
This comprises of transfers from family, friends and other households in the budget survey. We also include alimony payments. Although, we can identify how much each household type received in total, we do not know from which household type the payment was made. We will deal with this issue in the expenditure section.

Income from transfers (government to households) – entry (Household; Government).

This corresponds to social benefits and other current transfers. Here we include pensions, scholarships, social assistance, budget-funded social benefits and other social transfers.

Income from remittances – entry (Household; Rest of the World).
Kazakhstan's household budget survey does not have remittances per se, therefore we could not match it to a corresponding SAM entry. But, the amount of remittances would be included in income from inter-household transfers. For this reason, we calculate initial level of remittances by household types, by applying the same shares as in inter-household transfers. In other words, we take total level of remittances from the macro-SAM and distribution as in inter-household transfers from the KHBS. For the balancing procedure (discussed in detail in section 5) we need to define initial levels for all items, but, although macro-aggregates are fixed at their macro-SAM levels its composition can change as the result of the adjustment.

Expenditure_

Unfortunately, expenditure items, other than final consumption expenditure, are not covered by KHBS.

Moving along the household expenditure column:

Expenditure on final goods and services – entry (Commodities; Household).
Represent household final consumption expenditure. First, we consolidated all final expenditure items from the KHBS into 24 main aggregates, such as expenditure on food and drinks, transport, education etc. Then, it was matched to 57 sectors of the SAM (see section D.1 of the Appendix D). When there was more than one category of the SAM corresponding to a single item in the KHBS we kept the level from the latter for all household types and applied composition, as follows from the aggregated household consumption expenditure on those items. For example, there are three sectors in the SAM (agriculture and hunting; forestry; and fishery) that correspond to one generic agriculture sector in the aggregated KHBS data. We have the total household consumption of products from all three sectors and consumption is broken down by household types, but only of

generic agricultural products. In this case agriculture and hunting represent almost 99 percent of the three with forestry and fishery accounting for about 0.5 percent each. To obtain the consumption of all three products by all household types we multiply the consumption of generic agriculture by 0.99 to get the consumption by household of types of agriculture and hunting products and so on.

Transfers to firms – entry (Firms; Household).

This entry represents property income, social contributions and other current transfers paid by households and collected by firms. The expenditure section in KHBS02 does not allow us to isolate these kinds of payments; therefore we approximate it using shares from the income section. As mentioned earlier, property income dominates this entry and mostly rich urban households engage in this kind of activity, which involves property selling and buying, share trading etc. Therefore we think it is reasonable to appropriate the income shares for the expenditure part while keeping aggregate total from the macro-SAM unchanged.

Inter-household transfers – entry (Household; Household).

This entry represents exactly the same items as in the income component and is highly comparable across the SAM and Income/Expenditure from the KHBS. While we can calculate with some certainty, how much each household type receives and pays in total, there is no way to determine who pays to whom and who receives from whom. For example, from KHBS we can derive that total inter-household transfer payments distributed 64:36 percent, between urban and rural households accordingly. By applying these shares to total inter-household transfer number from the SAM, we can therefore find nominal values of urban and rural households' total expenditure for this item. However, we can not possibly know the structure of the payment between the types (urban-urban, urban-rural, rural-rural, and rural-urban). We estimate the full matrix by proportionally applying total income and expenditure shares of inter-household transfers. For example, transfers from urban to rural household would be estimated in the following way. If rural households received 26% and urban households paid 64% of the total transfer, then payment share from urban to rural estimated by multiplying 0.64 by 0.26 which is about 0.17 or 17% of total transfer. This way we consistently estimate the initial matrix of inter-household transfers based on how much each type spends and receives of it.

Social contributions – entry (Government; Household)

KHBS02 does not have social contribution separated out, therefore we disaggregate it by household types assuming a flat rate of social contribution (the same method was used for PIT below).

Direct taxes – entry (Direct taxes; Household).

As is the case with social contributions, KHBS does not cover personal income tax (PIT), but, since Kazakhstan has flat rate PIT, we can disaggregate based on total income shares of each household type. For each household type ratio of PIT to total income should be approximately the same. Therefore, to get a flat rate PIT for all household types we multiply each household's share of total income by total PIT from the SAM.

Household's saving – entry (Savings; Household).

The National Accounts report negative aggregate household savings in 2002, which is consistent with KHBS02. Savings for each household type are calculated as a residual element and thus balance the household accounts in the social accounting matrix.

The resulting SAM, disaggregated by household type (income deciles and type of settlement) is shown in the section D.2 of the Appendix D.

4.5. Balancing the micro-SAM

After a detailed macro-SAM has been constructed the data from the I-O tables and HBS can be used to build a disaggregated micro-SAM. Kazakhstan's I-O tables have 61 sectors, which are considered to be fairly substantial by international standards. However, there is a major problem with the quality of the I-O data in Kazakhstan. For example, statistical agency attempts approach the I-O aggregates to those in the national accounts. We often see that totals in the I-O are close to the totals in the National Accounts, but its individual elements do not add up to the indicated totals. This problem is profound in 2002 I-O tables, slightly less so in 2003 version and even less in 2005. Even when an I-O table is fully balanced, its aggregates are not always consistent with corresponding aggregates in the National Accounts. In Kazakhstan, the National Accounts are one of the most reliable sources of economic data, which are often quoted by the officials and academics. Therefore, consistency between the I-O and the National Accounts, is not only desirable for the construction of the micro-SAM, but would provide the most accurate representation of country's economic accounts. The same can be said about using micro-level household data to allow for more than one household type in the SAM. Calculated values are only broadly consistent with I-O and National Accounts data.

Both, the issue of balancing the micro-SAM as well as reconciling it with the National Accounts can be effectively addressed using the Cross Entropy (CR) method of estimating a SAM. Essentially we assemble the initial micro-SAM using whatever information there is without requiring equality between rows and columns, which can also be called an unbalanced micro-SAM. The estimation algorithm then uses all this information to find a balanced micro-SAM which is also consistent with the national accounts.

4.5.1. Cross Entropy and Least Squares

The CR method for SAM estimation was first used by Robinson *et al*. (2003).[31] The idea behind it is very intuitive and can be described as follows. Starting with an unbalanced SAM, we want to find such balanced SAM, which would minimise some entropy or disorder measure between two matrices. In the words of Robinson *et al*., (2001, p. 59) "The Cross-Entropy measures reflect how much the information we have introduced has shifted our solution away from the inconsistent prior…". More formally, suppose that $\boldsymbol{T}$ is the matrix of SAM flows and $\boldsymbol{y}$ is the vector of total row and column sums, so that:

$$y_j = \sum_i T_{ji} = \sum_i T_{ij} \tag{4.2}$$

where first and second subscripts refer to the row and column numbers correspondingly. As with fixed coefficients I-O model, the SAM coefficient matrix $\boldsymbol{N}$ could be constructed as:

[31] Robinson, S., Cattaneo, A., El-Said, M., 2001 **"Updating and Estimating Social Accounting Matrix Using Cross Entropy Methods".** Economic Systems Research, Vol. 13, No. 1.

$$N_{ij} = \frac{T_{ij}}{y_j} \tag{4.3}$$

Entropy measure I is then written as:

$$I = \sum_{i,j} N_{ij} \ln\left(\frac{N_{ij}}{\bar{N}_{ij}}\right) \tag{4.4}$$

This measure of entropy is due to Kullback-Leibler (1951) and was originally applied to measuring "cross entropy" distance between two probability distributions (Robinson *et al*., 2001). The problem is to find a new matrix $\boldsymbol{N}$, which minimises the cross entropy difference between the given matrix of coefficients $\bar{\boldsymbol{N}}$ and the new estimated matrix, and satisfies some a priory given constraints:

$$\min_N I = \sum_{i,j} N_{ij} \ln\left(\frac{N_{ij}}{\bar{N}_{ij}}\right) = \sum_{i,j} N_{ij} \ln\left(N_{ij}\right) - \sum_{i,j} N_{ij} \ln\left(\bar{N}_{ij}\right) \tag{4.5}$$

Subject to:

$$\sum_j N_{ij} y_j = y_i \tag{4.6}$$

$$\sum_j N_{ij} = 1, \quad 0 \le N_{ij} \le 1 \tag{4.7}$$

$$F^k\left(T\right) = x^k \tag{4.8}$$

where the last constrain represent all additional information that one wants to incorporate into the estimated SAM such as GDP, value added etc. In this case the last constraints are used to reconcile national accounts with I-O aggregates.

Alternatively, instead of minimising cross entropy difference (4.4) one could use a variety of other measures of disorder. More familiar in economics, perhaps is the least squares method of parameter estimation. In the current framework, rather than minimising entropy function (4.4) we minimise the sum of squared deviations in percentage terms S of estimated matrix $\boldsymbol{N}$ from an initially known matrix $\bar{\boldsymbol{N}}$:

$$S = \sum_{i,j} \frac{\left(N_{ij} - \bar{N}_{ij}\right)^2}{\bar{N}_{ij}} \tag{4.9}$$

It should be noted, that in both cases (cross entropy difference or sum of squared residuals) the emphasis is on minimising the structural distortion from the original SAM that is the distance from the matrix of coefficients, rather than flow values. The results from applying both measures of distortion will be compared when balancing the SAM for Kazakhstan.

4.5.2. Technical adjustments

Before using the I-O tables some adjustments to the published version have to be made in order for it to be usable and compatible with the macro-SAM. The procedure described below was done for 2002 version of the I-O tables.[32]

Starting with the unchanged tables in basic prices, the first objective is to make them square so that the number of rows equal the number of columns, and allocate trade and transport margins. For 2002 the breakdown of transport margins by types are not available, therefore all transport sectors were aggregated into one and generic transport margins were added to this sector. Wholesale trade margins were added to the wholesale trade sector and retail trade margin to retail trade sector. This adjustment implies that the difference between basic prices and consumer prices in the SAM is in indirect taxes only. One sector has been deleted from all tables as it is zero everywhere – "Услуги, предоставляемые экстерриториальными организациями и органами". Also adjustment for financial

[32] (2004) **«Таблица Затраты-Выпуск (МОБ)».** Statistical Agency of the Republic of Kazakhstan.

intermediation services was removed from the tables and will be allocated to sectors during the balancing.

After these adjustments have been made there are 57 sectors left and now we can insert unbalanced I-O data into the balanced macro-SAM:[33]

- Intermediate demand (entry – Commodities; Activities) – from table 1.1
- All indirect taxes (entries: Indirect taxes; Commodities, Export duties; Commodities, Intermediate taxes; Activities) – from table 2.5
- T on capital (entry – Taxes on capital; Activities) – from table 1.3
- Imports (entry – Rest of the World; Commodities) – from table 1.3
- Capital and Labour (entries: Capital; Activities, Labour; Activities) – from table 1.3
- Gross domestic output in basic prices (entry – Activities; Commodities) – from table 1.3
- Household's consumption in consumer prices (entry – Commodities; Household) – from table 1.2 + taxes from table 2.5
- Government's consumption in consumer prices (entry – Commodities; Government) – from table 1.2 + taxes from table 2.5
- Investments in consumer prices (entry – Commodities; Investments) – from table 1.2 + taxes from table 2.5
- Inventories in consumer prices (entry – Commodities; Inventories) – from table 1.2 + taxes from table 2.5
- Exports in consumer prices (entry – Commodities; Exports) – from table 1.2 + taxes from table 2.5

The optimisation program does not like negative entries in the SAM due to the use of logarithmic functions. If a cell has a negative value we add this amount both to itself (thus making it zero) and to its counterpart entry in the mirror row and column. This procedure does not change the identity between rows and columns and after the SAM has been

[33] Table references made to 2002 I-O tables in the publication as in footnote 3 above. Table 1.1 – I-O in basic prices; table 1.2 – Final demand in basic prices; table 1.3 – Gross value added; table 2.5 – Indirect taxes.

balanced negative entries are returned to its original position. Statistical discrepancy will be allocated to the investment column (gross fixed capital formation) during the balancing.

The balancing algorithm finds such a micro-SAM, which satisfies all traditional SAM constraints and is consistent with the macro-SAM, which has been built according to the National Accounts. The macro-SAM entries represent constraints for the estimated micro-SAM. The algorithm was implemented in GAMS software. To compare cross entropy difference measure with squared residuals, the latter was used first as the minimand, producing value of 0.115. Then, entropy function (4.4) was minimised and the estimated SAM was substituted into the sum of squared residuals (4.9) for N_{ij}. This allows finding the sum of squared residuals implied by the SAM estimated using the cross entropy method. The value appeared to be very close and only slightly higher at 0.116. However, when the entropy difference is minimised the algorithm converges only after about 5-10 minutes, whereas in the case of squared residuals, the convergence is in a matter of seconds. Therefore, while producing similar outcome, the least squares method is faster and is less likely to cause the collapse of the algorithm.

Micro-SAM for Kazakhstan 2002 can be found in the section D.3 of the Appendix D.

4.5.3. Adjustments for the CGE model

The SAM, constructed using the procedure described above, can be readily used as a modelling and analytical tool (see for example Pyatt, 1988). However, before it can be regarded as a proper dataset for a standard CGE model, some further modifications need to be made. Unfortunately, often some degree of detail has to be sacrificed (depending on the structure of the model), in order to reconcile a SAM with the CGE framework at hand. Accordingly, this section describes all steps that need to be followed to convert a SAM as above into a CGE model dataset.

It is possible there are negative entries in the capital row and investment column. To deal with it the following procedure was used: if there are negative entries in the capital row, this entry made the same but positive and the same value was added to the corresponding entry in investment column. Negative entries in the investment column were made equal to zero and the same value was added to the corresponding entry in the capital row. Both items were originally calculated as residuals in the compilation of the National Accounts, thus this adjustment does not change any “real” data. Since the savings of institutions are a residual of income and expenditure balance, negative savings in household account for the most part represent underreported income. Without any additional knowledge about the source of underreported income, negative household’s savings were substituted with zeroes and the corresponding difference was first subtracted from firm’s savings and added to firm’s transfers to household to keep the balance of rows and columns.

We assume that only households and firms receive capital income, and all labour income goes to households. Therefore, government’s receipts of capital income (entry – (Government; Capital)) was made equal to zero and allocated as transfers from household to government. Labour income from the rest of the world and labour income to the rest of the world (entries – (Labour; Rest of the World) and (Rest of the World; Labour)) were deleted and also allocated to the household’s labour income. The difference was added/subtracted to/from the household’s transfers with the rest of the world.
Inventories are usually not dealt with explicitly in the CGE models and therefore are aggregated with investments/savings account, as a result, represent gross fixed capital formation.

Cross-institutional transfers (household – household, government – government) would cancel each other out in the model, hence these entries were made equal to zero. This does not alter the SAM identities.

Within the basic SAM framework, exports are treated as part the commodity account. Most of the CGE models on the other hand, have exports in the production account (activities) since total domestic output usually expressed as a transformation function between exports and supply to the domestic market. Hence, exports shifted from the activity account to the commodity account and the gross domestic output (entry Activity; Commodity) was adjusted accordingly. Export duties similarly moved from commodities to activities.

The structure of the resulting SAM for 2002, ready for CGE use, is shown in Table 4.10. For presentation purposes, the disaggregation by households and by sectors has been suppressed.

Table 4.10. Macro-SAM Modified According to the Requirements of the CGE Model

	Com	Act	K	L	H	G	TC	TE	TK	TI	TM	TY	Invest	R	Total
Com		3925515			2205940	434999							1101610		**7668064**
Act	5841413													1781690	**7623103**
K		1964842													**1964842**
L		1429195													**1429195**
H			1964842	1429195		122189									**3516225**
G					276750		78690	81049	110459	112043	0	259668		0	**918658**
TC	78690														**78690**
TE		81049													**81049**
TK		110459													**110459**
TI		112043													**112043**
TM	0														**0**
TY					259668										**259668**
Savings					680830	313544								107236	**1101610**
R	1747961				93038	47927									**1888926**
Total	**7668064**	**7623103**	**1964842**	**1429195**	**3516225**	**918658**	**78690**	**81049**	**110459**	**112043**	**0**	**259668**	**1101610**	**1888926**	

4.6. Conclusions

The purpose of this paper has been twofold. The first goal was to show all the steps, which are necessary to construct a detailed Social Accounting Matrix for the country like Kazakhstan. The resulting SAM is highly disaggregated with 57 sectors and 10 household types, which makes it a valuable policy tool that can be used by government, research centres and academics in the field. The second goal was to provide a detailed documentation for the data used within CGE model in the Chapter 5 of this thesis and give a detailed snapshot of Kazakhstan's economic structure at the start of the oil boom.

A highly aggregated, macro-SAM was constructed first using mostly readily available National Accounts data. The description of each SAM's entry demonstrates how the system of 1993 UN National Accounting framework can be utilised to build a consistent macro-SAM. At the second stage 2002 HBS data was matched to the household income and expenditure structure of the macro-SAM. Finally we put together a macro-SAM, several household types and Input-Output tables in a single disaggregated micro-SAM. To reconcile he data from the different sources we used cross entropy and least squares methods of adjustment. The final micro-SAM for 2002 is fully consistent with Kazakhstan's National Accounts.

Last, we show how the micro-SAM needs to be adjusted for it to be used as a dataset in a relatively standard CGE model as in the one described in Chapter 3.

CHAPTER 5

Estimating the Economy-wide Impact of the Oil Industry and its Contribution to the Economic Growth

5.1. Introduction

The collapse of the Soviet Union has been accompanied by the major economic turmoil in the successor states. Former Soviet Union (FSU) countries generally followed similar paths through the transition from a state planned to a market regulated economy, although with varying degree of success. While some like Ukraine are yet to achieve pre-independence level of GDP, others, like Kazakhstan, enjoyed double digit economic growth and have exceeded their 1991 GDP level several years ago.

It is generally agreed that oil and gas industry played a leading role in Kazakhstan's booming development following the collapse of the Soviet Union and initial economic downturn. High energy prices and recent discoveries of additional reserves induced massive investments in the industry, making Kazakhstan an important player on the international energy markets. For the domestic economy, it created demand driven growth fuelled by the export of natural resources. But, what would the development path of Kazakhstan look like if there were no oil and gas industry? Its impact has never been assessed properly, the official statistics suggest a rather modest share of this sector in the country's value added structure and hence its contribution to the economic growth. Official estimates of the economic impact of the oil industry do not go beyond simple GDP or Value Added shares calculations.

The living standards of the population have also been improving steadily after a dramatic decline in the early transition years. The income and consumption level might now be growing rapidly now, but it remains to be analysed of what that implies for the evolution of income distribution in Kazakhstan? With growth rather heavily focused around a few sectors, are its benefits similarly concentrated, or is the general population enjoying improving living standards?

This paper proceeds as follows. First, it provides a theoretical background and literature review for the simulations. Second, this study presents calculations on simulated average annual impact of the oil industry growth on the economy as a whole, which provide an indication of to what extent the total economic growth can be attributed to the oil industry. This is done with the help of a Computable General Equilibrium model of Kazakhstan. It becomes possible to demonstrate how the expansion of minerals production has a spillover effect on the rest of the economy via inter-industry linkages, final consumption and other mechanisms. Moreover, the results from two alternative current account closure rules are compared to assess potential Dutch Disease effects. Finally, using Kazakhstan's household budget survey and results of the model simulation the estimates are done on how the recent booming development of the oil and gas industry affects income inequality and poverty in Kazakhstan.

5.2. Methodology and Motivation

5.2.1. Motivation

Each sector's contribution to overall GDP growth can be estimated based on the value added share in GDP and indices of physical volume[34]. The mining industry's direct contribution to the overall GDP growth was on average 1.4 percentage points in 2000-2007 of the total 10.2 percent real GDP growth in the same period. In other words 13.7 percent of annual economic development that occurred in that period was due to the mining industry. This is clearly only a part of the picture as at least inter-industry links are not accounted for in such estimation. When a booming industry buys intermediate inputs from other sectors it, in turn, stimulates their development and hence indirectly contributes to GDP growth. Another channel through which oil boom can affect the rest of the economy is by changing the aggregates of the final demand. As oil revenues go up income rises and hence private consumption and investment, which further stimulate domestic production. Depending on the fiscal policy, an increase in government revenues due to the oil windfall is likely to boost services such as health, education and construction (via large infrastructure projects).

[34] Based on tables in the section A.1 of the Appendix A

The IMF (2005) used a broad measure of the oil sector to give a more accurate estimate for its contribution to Kazakhstan's economic growth. A broad measure was defined including not only value added in crude oil extraction, but also associated goods and services, the industry's investments, and the oil refining industry. After an adjustment, 40 percent of construction and 10 percent of transportation value added was reallocated to oil. Likewise, out of 9.5 percent GDP growth between 1999 and 2003, the broad oil sector's contribution was 3.5 percentage points with 1.2 attributed to direct value added and 2.3 to the related services. It should be noted that the adjustment was done on the linear basis and does not include any impact related to the final demand variations or price changes. A comparison of these results against the results obtained during the course of this study is presented in a subsequent section.

Kazakhstan's economy has been developing along with an expanding oil sector since the beginning of transition. A thriving extraction industry greatly contributed to the successful development of other sectors, such as services transportation and construction. Additionally, other mining and metal production sectors are also performing comparatively well[35]. Produced coal is mainly intended for electricity and heat generation and some amounts – for export to Russia, whereas metals are primarily export-oriented. With 19% of the global total uranium reserves, Kazakhstan is the world's third largest uranium producer (after Canada and Australia). All in all, Kazakhstan utilized its comparative advantage of having a rich endowment of natural resources and has initially focused on capital intensive production with a great spillover effect on the rest of the economy. This suggests that so called Resource Curse and Dutch Disease models are not exactly applicable to analysing Kazakhstan's experience. Moreover, they can be misleading. Instead, another model seems more appropriate, namely the one proposed by Douglas North in 1955, to describe economic regional development in the United States.

[35] See section A.1 of the Appendix A for the statistics by sector

5.2.2. Theoretical Background and Literature Review

According to the classical regional growth theory, there are five subsequent stages of regional economic development starting from a mostly agricultural, self-sufficient subsistence economy and progressing to export-oriented tertiary industrial production[36]. The final fifth stage of regional development is the most difficult one to achieve, it represents a situation when a region specializes in tertiary production for export and supplies less developed regions with services goods and capital. However, North (1955) asserts, that this last stage is not evident and moreover, not essential for a sustained economic growth. Unlike neoclassical model, which assumes that primary and secondary sectors compete for scarce region-specific resources, North (1955) suggested that their growth is complementary. North uses the term "export base" to define those highly successful industries of the region, which exports goods or services to other regions. The export base manufacturing production is not a necessary condition for sustainable development of a region. Secondary and tertiary industries that develop due to the export base will help to broaden the export base in the future.

In the same study North suggests that an indirect effect of the export base is by far more important to the economy than a direct one. An output of residential industries depends exclusively on local demand, which is fuelled by an expansion of the export base and hence the two are closely interlinked. High revenues generated by the export base help to maintain a high level of spending and investment and hence sustain production of a wide range of services and goods in the domestic market, which have a potential to expand the export base in the future. Therefore, the region's main growth driver is its successful export base. Thus, to understand and promote growth it is necessary to understand what geographic, political and other factors were fundamental in developing the export base. While to measure its economic impact, it is vital to account for all those relevant direct and indirect effects.

A theory developed by North although fundamentally grounded in the US economic development can be applied to other countries if they meet the following two criteria (North, 1955 pp. 243-244): "1. Regions must have grown up within the framework of the

[36] North (1955) referring to Hoover, E. M. and Fisher, J., 1949 "Research in Regional Economic Growth". NBER, chap 5.

capitalist institutions and have therefore responded to the profit maximizing opportunities, in which factors of production have been relatively mobile. 2. Regions must have grown up without the strictures imposed by population pressure."

Both of these statements are true for Kazakhstan after 1998. In fact, for economic purposes North (1955) proposes to redefine a region as a combination of industries concentrated around a common export base. In Kazakhstan, the economy was regulated by market forces and all prices have been liberalised by the late 1990s, including the exchange rate. The Russian financial crises speeded up economic restructuring rendering labour and capital move from less competitive sectors. Another important factor is that Northian model focusing on regional development does not include the exchange rate which is irrelevant in that setting. The exchange rate appreciation caused by the export revenues could have significant negative impact on other tradable industries making their output relatively more expensive. However, by the end of the Russian financial crisis in 1998 mining and metals emerged as virtually the only exporting industries, thus being themselves responsible for any appreciation of the real exchange rate. Kazakhstan's export base has broadened since, at least, in one sector. Kazakh banking and financial services are considered to be the best in terms of performance among the FSU countries and have already expanded into neighbouring countries. For example, according to the IMF (2008), in 2007 Kazakh banks accounted for 45 percent of all credits in Kyrgyzstan. It holds true that a fair amount of recognition has to be given to prudent government policies and the regulation of this sector, but the oil boom has been quintessential to success. Initially concentrated on mining industry banks gradually developed into other markets. An increased income stimulated private savings and investment managed through an already buoyant financial system.

Few authors implicitly embodied this framework in an attempt to estimate a wider contribution of the industry to the economy. Perhaps the most important for this study is the study by Ahammad and Klements (1999), who first considered the wider impact of the mineral industry in Western Australia (WA). The minerals industry played a significant part in the development of Western Australia in the 1990s. To estimate the degree of its importance for the local economy authors attempted to answer a question of what the development of WA would look like if there had been no minerals growth. Using a CGE framework the answer was found in three stages. First, the average growth rates for WA minerals in the 1990s were determined, which then regarded as a typical annual growth. Second, those growth rates were used as an exogenous shock in the CGE model. Finally, by changing the signs of all the simulation results, the impact was interpreted as a loss of the economic activity that would occur if there was no expansion of the minerals sector. Conducted simulations showed that the minerals sector accounted for around 50% of the total Gross State Product (GSP) growth in Western Australia. However, as expected, the results were sensitive to the model specification. Since the growth of the minerals production implies real appreciation of the exchange rate, the highest contribution to growth was observed when wages were fixed and the nominal exchange rate was fully flexible, as it entailed the smallest real appreciation. An employment level estimated separately using the linear relationship between GSP, real wages and employment growth rates was estimated to be 1.4% less in a typical year without minerals expansion.

In the follow up to the initial study by Ahammad and Klements (1999), Ahammad (2002) decomposed the agricultural output growth in WA into the growth of inputs to agricultural production and increase in productivity. He has shown that indirect benefits of agriculture, which are often not accounted for when analyzing sectoral contribution, were by 1.5 times greater than its direct contribution.

The current study follows a somewhat similar approach as in Ahammad and Klements (1999). However, rather than focusing on supply shock, we concentrate on the demand side and simulations are made of a several years average annual export growth of the oil industry in Kazakhstan. Using the CGE model allows to capture combined impacts of all factors such as inter-industry linkages, private and public spending, exchange rate, and other which are not accounted for when other techniques are used. Using the Northian framework and a Computable General Equilibrium modelling approach, the following sections present an attempt to estimate the spillover effect of the oil boom on Kazakhstan's economy and a distribution of its benefits among general population.

5.3. Model and Data[37]

5.3.1. CGE Model for Kazakhstan

The model belongs to the 1-2-3 class of CGE models and makes use of assumptions that are largely considered standard in the CGE literature. Employing these assumptions has several important implications for this study. Firstly, it makes it easier to trace the forces that lay behind a particular outcome and hence facilitates the tractability of results. Secondly, the model as a whole is flexible enough to incorporate features specific to Kazakhstan's economy.

The model is static in the sense that no inter-temporal decision making is involved. All industries are assumed to be perfectly competitive, meaning zero (super-normal) profit is earned by the firms. The small country assumption ensures that Kazakhstan is treated as a price taker on the world market, implying that Kazakhstan's import and export decisions do not affect the prevailing international prices.

There are 18 sectors (industries) in the model, each produces only one commodity. All industries produce output according to the nested structure of their production function. At the top nest composite intermediate good combined with composite value added in the Leontief's production function. At the lower nest, composite value added is the CES function of capital and labour, while composite intermediate is Leontief's function of all commodities produced by different sectors.

There are ten household cohorts defined according to their income levels. Consumption demands are defined by the linear expenditure system (LES) with a subsistence consumption vector that each household has to achieve before it can enjoy any additional consumption. Income elasticities of demand are imposed from the outside, whereas the subsistence levels for each household group are calibrated based on their consumption and income structure. The magnitude of the subsistence level can determine to what extent the

[37] In this section main features of the data and model will be concisely described, whereas detailed description can be found in Chapter 3 of this thesis.

consumption of a particular good is demand- or supply-side driven. Larger (smaller) shares make demand less (more) responsive to variations in prices or income.

Government is assumed to have fixed expenditure shares calibrated using C-D utility function.

5.3.2. Data

A large number of parameters of the CGE model was calibrated for the year 2002 using a Social Accounting Matrix constructed in the Chapter 4 of this thesis. The remaining parameters, except for those discussed separately, were adapted from existing literature.[38] SAM originally had 59 sectors, however for the purposes of this study it has been aggregated to 18 sectors. SAM, which is used as a dataset in the CGE model is slightly different from the classical SAM due to a number of modelling conventions it has to follow. All adjustments required for this are discussed in detail in Chapter 4.

To estimate the impact on welfare of different household types, in addition to the CGE model the study uses 2002 household budget survey data compiled by the Statistical Agency of the RK. The survey is a valuable source of information. It covers 12,000 individuals and is designed to be representative at the regional level. Some statistics based on the survey are presented in a consolidated form in Chapter 1, while detailed description of the source as well as a discussion of the various data issues can be found in Chapter 4 and in Hare and Naumov (2008).

5.4. Simulations and Results

5.4.1. An Oil Boom Simulation and Macro Closures

To show how the development of the oil and gas sector spillovers to the rest of the economy, it is necessary to isolate its average annual growth and introduce it as a shock to a

[38] Whenever possible, parameters are from Jensen and Tarr (2007)

balanced model. The counterfactual adjustments that will take place in the model can then demonstrate how much of the actual total economic development can be attributed to the oil industry. For example, if the GDP in that period grew on average by 10 percent annually and simulation implied GDP growth of 4 percent, this is interpreted as follows: out of the 10 percent annual growth that happened in 2001-2005, 4 percentage points were due to the oil industry. There is another interpretation for such simulation employed by Ahammad and Klements (1999). If signs of all changes triggered by the exogenous shock are reversed (that is instead of GDP growth of 4 percent a decline of 4 percent is used and subtracted correspondingly from the actual figures), it is possible to calculate an estimate of what the economic development would have looked like in the absence of the oil industry. Bearing in mind the latter interpretation, the former interpretation is used in the discussion that follows, as it is in line with the rest of the paper.

We use an aggregate demand shock generated by an increase in oil export by the real annual average experienced over the period 2001-2005. Over these years, Kazakhstan's oil exports have grown at a rate of 18 percent per year on average. An increase in demand for export stimulates output expansion and requires primary production factors such as labour and capital as well as intermediate inputs, which could be provided by other sectors of the economy or imported. The aim is to measure the medium-term average annual impact on the economy, therefore it is assumed that those sectors which provide services to the oil industry would be able to acquire new capital and labour needed to increase production for the domestic market at prevailing market prices. The validity of this assumption can be tested relatively easily. Assume, for example, that output of the construction industry had been growing on average by 10 percent in the same period. Further assume that a simulated demand shock from the oil sector showed that construction would need to have been growing by 12 percent to meet this demand. Such outcome would violate our assumption that construction was able to obtain capital and labour to increase production in response to a shock from the oil sector. However, a simulation resulting construction growing below or at 10 percent is perfectly feasible according to the real data and therefore attributed to the oil sector stimulated growth.

Sector-specific capital demand is assumed, and capital accumulation is made demand driven, constrained by the sector-specific capital prices which are the weighted average of the prices of capital goods used by the different industries (3.36).

$$PK_{\mathrm{i}} = \sum_{j=1}^{n} w_{ij} P_{\mathrm{i}} \,, \tag{3.36}$$

where PK_i is the sector-specific price of capital, P_i are the market commodity prices including capital goods and w_{ij} are the capital composition weights for each sector and $\sum_{j=1}^{n} w_{ij} = 1$. Only a few countries construct capital composition matrix which is necessary to estimate the capital weights w_{ij} and unfortunately Kazakhstan is not one of them. Assuming that the main industries on average use similar capital goods capital composition weights were approximated by those calculated by the Bureau of Economic Analysis (BEA) for the US economy in 1997 (see Appendix C, Table C.1.1).

Total labour supply is fixed, but the amount available for production could vary as workers move in and out of unemployment according to the wage curve, which is essentially a Phillips curve type of relationship.

The exchange rate is fully flexible with foreign savings and foreign transfers being fixed at their initial level. This implies that the current account is balanced through the exchange rate appreciation rendered by the oil export expansion. Since foreign prices are treated as constant the appreciation occurs only due to a real increase in export and is not affected by the world prices. It resembles the base scenario and the situation in Kazakhstan where although government extracts some oil revenues and channels it into foreign assets via the oil fund, the rule of thumb for that is based on the world price of oil rather than on real production. More formally, out of all revenues that government receives from the oil sector, it spends only the amount based on the 19 dollars per barrel price of oil. The remaining part is placed into the national oil fund. Since the model was calibrated based on the data that already incorporated that, if no world oil price change occurs no additional money is added to the oil fund by the government.

To summarise, this simulation isolates the oil sector growth through exogenous 18 percent increase in the export of oil. The impact can be considered as medium-term because of demand driven capital and labour accumulation. This scenario is called for to estimate an average annual contribution of the oil industry to the economic development that occurred in the years of rapid expansion of the oil sector.

5.4.2. Results

An exogenous increase in demand from the oil sector had a profound impact on the rest of the economy. A simulated increase of oil export by 18 percent resulted in a 12.5 percent increase in domestic production of this commodity. For comparison, in 2001-2005 an actual oil output grew by an average of 11.5 percent annually. Projected sectoral output growth is in line and not overshooting real occurred growth, that is simulated average annual sectoral growth is less than or equal five year average real annual output growth.[39]

Kazakhstan's real GDP grew by an impressive 10 percent annually over the same period. The simulated oil industry shock resulted in real GDP growth of 4 percent. Hence it is concluded that the oil industry accounted for about 40 percent of the country's economic growth in the period 2001-2005, either directly (via a direct increase in production) or indirectly (via inter-industry linkages and other effects). It should be noted that the direct impact puts the oil sector contribution at 1.5 percentage points only, whereas the IMF's broad measure attributes 3.5 points to the oil industry. Kazakhstan sustained a two digit real GDP growth all the way through 2007. However using the Ahammad and Klements (1999) interpretation, in the absence of the oil sector, the economy would have been growing only at about 6 percent annually, which is less than 7 percent of the actual average growth of the other former Soviet republics (excluding energy rich Russia and Azerbaijan, as well as Armenia, which showed surprisingly high growth during the considered period).

[39] For more sectoral details see table A.1.2 of the Appendix A.

Table 5.1. Simulation Results (in annual % change)

	X	XD	XDD	G	C	E	M	K	L
1. Agriculture	1.6	0.5	1.4	6.1	2.2	-1.7	6.3	0.9	-1.2
2. Forestry	1.4	1.0	1.1	6.6	2.7	-1.2	4.6	1.4	-0.7
3. Fishery	1.7	1.7	1.7	6.8	2.8	0.0	4.3	1.8	-0.3
4. Mining of coal, lignite and peat	0.0	-1.7	-0.1	5.2	1.4	-4.9	7.4	-0.3	-2.2
5. Crude oil extraction	**7.1**	**12.5**	**9.2**	**0.0**	**0.0**	**18.0**	**-4.0**	**12.6**	**11.7**
6. Other mining	-4.4	-4.7	-4.5	0.0	2.2	-7.4	-0.2	-3.6	-5.4
7. Food, clothes, tobacco	2.9	1.1	1.2	7.0	3.1	-1.3	5.0	1.8	-0.1
8. Fuels and chemicals	2.8	1.7	1.9	7.4	3.6	0.7	3.7	2.2	0.3
9. Metals and metal products	2.0	-5.1	-1.2	0.0	1.5	-7.9	9.7	-4.2	-6.1
10. Other manufacturing	3.6	-1.8	-0.9	7.4	3.6	-4.4	4.6	-0.4	-2.3
11. Electricity, gas and water	1.6	1.5	1.6	6.5	2.7	-0.7	5.1	2.8	0.8
12. Construction	5.1	4.3	4.3	0.0	3.1	0.4	8.4	5.4	3.2
13. Trade	2.6	1.8	2.6	6.1	2.5	-0.4	7.3	2.3	0.3
14. Hotels and restaurants	3.1	3.1	3.1	6.1	2.7	0.0	0.0	4.0	2.1
15. Transport	2.3	2.0	2.0	6.7	3.0	-0.1	5.2	3.0	0.8
16. Post and communication	2.8	2.3	2.5	6.3	2.7	-0.4	7.0	3.2	1.2
17. Financial services	6.5	5.7	5.8	6.3	2.7	2.5	10.8	6.5	4.6
18. Public and other services	4.6	4.3	4.5	5.7	2.2	0.7	10.6	5.8	3.9
Overall	**3.4**	**3.0**	**2.8**	**6.1**	**2.9**	**5.4**	**5.5**	**4.3**	**1.3**

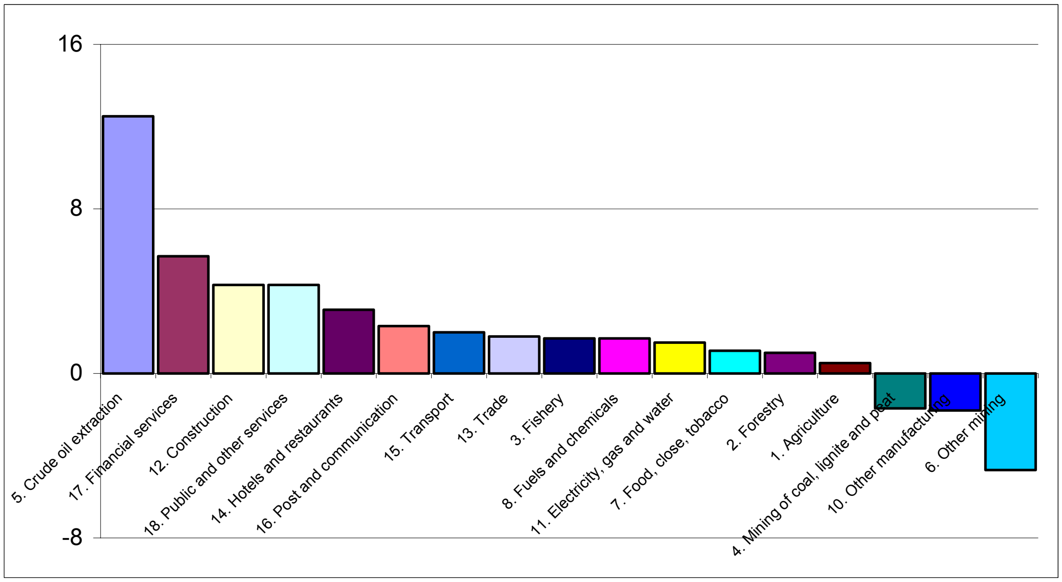
X – total supply; XD – total output; XDD – output sold on domestic market;
G – government final consumption; C – household final consumption; E – exports; M – imports;
K – capital demand; L – labour demand.

The government demand responded with the highest relative rise compared to other macro aggregates. It grew by 6.1 percent overall and was mostly driven by an assumption that in the absence of change in the world oil price, the government spends all oil revenues according to fixed expenditure shares. Although some industries benefited less than others, the overall economic activity measured by a total output, rose by 3 percent geared by the oil sector expansion. Private consumption grew by 2.9 percent (discussed in more detail in Section 5.4.4).

Several clear winners and losers emerged from this simulation. An additional demand created by the oil sector stimulated production first of all in sectors which have strong links with the oil sector itself, or in other words, supply intermediate goods and services that allow oil sector to expand. This is called a first order effect. Further along the line, these secondary industries also require intermediate inputs for their own production to increase – second order effect, and so on. On the other hand, the sectors that do not have particularly strong links with the oil industry but compete for the same intermediate inputs and production factors, are faced with increased prices combined with cheaper imports for their products in the absence of any stimulus to produce more (Figure 5.1 displays output change by sector after the shock). The increased demand made real wage rise by 1.8 percent and capital price (being sector specific) changed between -0.3 and 1 percent. The lowest number being agriculture and the highest - oil sector. For example, construction, financial and public services expanded by most in relative terms, whereas other mining industries and manufacturing (except for food and fuel) shrank. This does not mean however that the booming oil sector unequivocally leads to contraction in output of other mining and manufacturing. The correct interpretation would be to say that their output would have been larger by that percentage in the absence of the booming oil industry.

To offer more intuitional explanation of why some industries would shrink as the result of the demand shock from the oil industry, consider the coal mining industry. When the model is in equilibrium the supply of coal is equal to demand at the prevailing relative prices of intermediate goods and relative factor prices. An exogenous increase in the export of oil implies an increase in domestic output of oil because production is assumed to follow a CET function where domestic production and export are not perfectly substitutable. This is why exports may rise slightly for industries where the effect of the oil shock is strongest, such as construction and financial services. This might seem counterintuitive since there is no reason that export should rise as a result of the domestic increase in demand, although it is a standard way to model production and the impact can be somewhat mitigated by making CET elasticity close to 1 for industries with high export/domestic production substitution such as oil industry and making it inelastic for industries such as construction, which can not as easily shift output between foreign and domestic markets. Increases in the output of oil will require increases in intermediate inputs as well as capital and labour, which will drive up the price of those intermediates inputs and production factors. Coal mining industry uses similar capital goods as the oil industry, but supplies almost no intermediate inputs to it. Hence it is faced with almost no change in demand for their output but increased factor and intermediate good prices as well as real exchange rate appreciation. Output in coal mining sector must go down to restore back the equilibrium at which supply equals demand, but at new relative prices.

Figure 5.1. Impact on Total Output (% change)



5.4.3. Dutch Disease – Curse or Blessing?

Currently Kazakhstan is in an entirely different situation than the one it found itself after the Russian financial crisis in 1998. Rather than capital flights, fiscal deficits, and general economic uncertainty, Kazakhstan is facing a period of strong confidence, fiscal surpluses, and growing capital inflows. In 1998, the monetary authorities faced the question of how much let the exchange rate to depreciate, while today the question is how much allow the exchange rate to appreciate. Table 5.2 shows the structure of foreign trade and output in Kazakhstan net of taxes in millions of 2002 KZT. Industries such as Agriculture, Mining, Oil Crude Oil, Metals have large share of export in output and hence in the absence of other factors would be the first to suffer from real exchange rate appreciation. Others such as Construction and Financial Services less depend on export while cheaper imported alternatives are possible for these services.

Table 5.2. Supply and Trade in 2002 (millions KZT)

	XD	E	M	E/XD	M/XDD
1. Agriculture	3800	1110	100	29%	4%
2. Forestry	50	2	5	4%	9%
3. Fishery	170	0	1	0%	0%
4. Mining of coal, lignite and peat	1030	350	9	34%	1%
5. Crude oil extraction	10560	7580	600	72%	20%
6. Other mining	2350	160	100	7%	5%
7. Food, close, tobacco	7860	260	6520	3%	86%
8. Fuels and chemicals	2510	750	1840	30%	105%
9. Metals and metal products	7100	4410	1190	62%	44%
10. Other manufacturing	1080	290	3700	27%	468%
11. Electricity, gas and water	3490	7	50	0%	1%
12. Construction	4840	1	1230	0%	25%
13. Trade	8200	2310	1	28%	0%
14. Hotels and restaurants	690	0	0	0%	0%
15. Transport	6740	30	750	0%	11%
16. Post and communication	1080	90	80	8%	8%
17. Financial services	7680	150	1260	2%	17%
18. Public and other services	6200	340	50	5%	1%
Total	75430	17840	17486	24%	30%

XD – total output; XDD – output sold on domestic market;
E – exports; M – imports

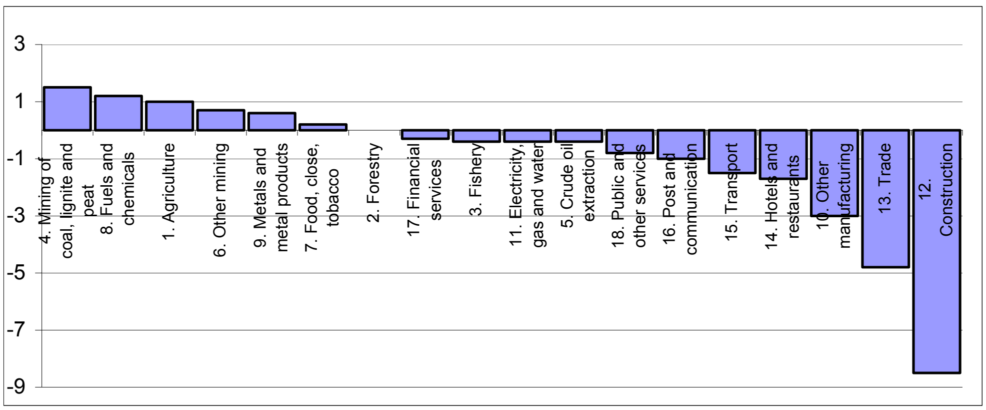
As a result of the increased oil export the real exchange rate appreciated by 1 percent, thus balancing the current account and rendering export more expensive compared to imports. As a result, export declined and import increased for most industries. This is the familiar Dutch Disease effect and it demonstrates how oil sector puts a significant downward pressure on manufacturing, agricultural and other-mining exports in Kazakhstan. On the other hand, cheaper imports could provide further boost to sectors whose production is intensive in imported intermediate products and to final demand. In sum, an overall macro-economic outcome can be either positive or negative for the country depending on which effect is stronger.

To test the impact of the real exchange rate appreciation the same scenario is repeated, but an alternative current account closure rule is used. Namely, the real exchange rate is now fixed and foreign savings are allowed to balance the current account contrary to the main scenario closure, where the exchange rate is fully flexible and foreign savings are fixed.

Because the real exchange rate is fixed foreign savings must fall to counterweight the oil export shock. Essentially, this closure rules means that all additional export revenues would be channelled abroad and invested into foreign assets to prevent exchange rate appreciation.

A breakdown of the results can be found in Table 5.3, additionally Figure 5.2 shows the net effect on the output growth which is a difference between two closure rules (output change under fixed real exchange rate minus output growth under flexible).

Figure 5.2. Net Change in Output (fixed minus flexible)



As expected the output of export oriented agriculture, mining and heavy manufacturing (such as metals) is greater under a fixed exchange rate regime. However, other manufacturing as well as financial services and construction are highly dependent on imports for intermediate inputs and domestic demand to sell their output. It is evident from Table 5.3 that without oil revenues in final demand and ability to buy cheaper imports these industries have to cope with higher domestic prices and in some cases might be forced to reduce their output (for example, construction industry). Generally, the oil sector expansion under the fixed real exchange rate damages non-tradable and import intensive sectors. Although total import is lower and total export is higher, the output and GDP grow by less. The GDP rose by 2.5 percent only, contrary to 4 percent when the real exchange rate was flexible, so did final consumption demand which grew by 1.6 percent instead of 2.9 accordingly.

This result implies that some modest real appreciation is actually beneficial for Kazakhstan's economy in the presence of booming oil industry when an alternative is to invest oil revenues abroad. Such policy aimed to constraint appreciation might be counterproductive. Indeed, as shown in Figure 1.4 about 90 percent of total export is raw materials or metals. Both are very competitive internationally and probably would not be affected much by moderate real appreciation that is mostly created by those sectors. Whereas most other industries produce for local consumption and dependent heavily on imported intermediate inputs and domestic demand, thus cheaper imports extra demand stimulus would help them reduce cost and expand production. Rather than thinking about how to prevent Dutch disease the government policy should focus on how to develop the economy in a presence of virtually all symptoms of the phenomena, namely, appreciating exchange rate, growing unit labour cost with no increase in productivity and increasing revenues from natural resources.

Table 5.3. Fixed vs Flexible Real Exchange Rate Closure (in annual % change)

	Output (XD)		Export (E)		Import (M)	
	Flex	Fix	Flex	Fix	Flex	Fix
1. Agriculture	0.5	1.5	-1.7	1.3	6.3	1.9
2. Forestry	1.0	1.0	-1.2	0.7	4.6	1.6
3. Fishery	1.7	1.3	0.0	1.2	4.3	1.4
4. Mining of coal, lignite and peat	-1.7	-0.2	-4.9	-0.6	7.4	0.8
5. Crude oil extraction	**12.5**	**12.1**	**18.0**	**18.0**	**-4.0**	**-16.8**
6. Other mining	-4.7	-4.0	-7.4	-4.2	-0.2	-3.8
7. Food, clothes, tobacco	1.1	1.3	-1.3	1.3	5.0	1.5
8. Fuels and chemicals	1.7	2.9	0.7	5.2	3.7	-2.3
9. Metals and metal products	-5.1	-4.5	-7.9	-4.6	9.7	-3.8
10. Other manufacturing	-1.8	-4.8	-4.4	-5.2	4.6	-4.1
11. Electricity, gas and water	1.5	1.1	-0.7	1.9	5.1	-0.2
12. Construction	4.3	-4.2	0.4	-4.5	8.4	-4.0
13. Trade	1.8	-3.0	-0.4	-2.9	7.3	-3.5
14. Hotels and restaurants	3.1	1.4	0.0	0.0	0.0	0.0
15. Transport	2.0	0.5	-0.1	0.9	5.2	-0.1
16. Post and communication	2.3	1.3	-0.4	0.8	7.0	2.1
17. Financial services	5.7	5.4	2.5	4.7	10.8	6.3
18. Public and other services	4.3	3.5	0.7	2.7	10.6	4.9
Overall	**3.0**	**1.8**	**5.4**	**6.4**	**5.5**	**-1.2**

X – total supply; XD – total output; XDD – output sold on domestic market; G – government final consumption; C – household final consumption; E – exports; M – imports; K – capital demand; L – labour demand.

5.4.4. Impact on Poverty and Inequality

Table 5.4 shows how the final consumption demand for each household cohort changed resulting from the simulated oil sector expansion. The household cohorts defined according to their income level on the scale from 1 to 10 with H1 being the poorest and H10 the richest. It is evident that the real consumption growth is generally higher for higher income households than for the lower ones. One reason could be that subsistence level consumption is higher for the low-income households and therefore total consumption is less responsive to variation in income.

Table 5.4. Impact on Private Consumption by Household Type (% change)

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10
1. Agriculture	0.7	1.1	1.5	1.5	1.9	2.5	2.7	3.0	3.0	2.9
2. Forestry	1.1	1.5	1.9	2.0	2.3	3.0	3.1	3.4	3.4	3.3
3. Fishery	1.2	1.7	2.1	2.2	2.5	3.1	3.3	3.6	3.6	3.5
4. Mining of coal, lignite and peat	-0.2	0.2	0.7	0.7	1.0	1.7	1.8	2.1	2.2	2.0
5. Crude oil extraction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6. Other mining	0.7	1.1	1.6	1.6	1.9	2.6	2.8	3.0	3.1	3.0
7. Food, close, tobacco	1.4	1.8	2.3	2.3	2.6	3.3	3.5	3.8	3.8	3.7
8. Fuels and chemicals	1.8	2.2	2.6	2.7	3.0	3.7	3.8	4.1	4.1	4.0
9. Metals and metal products	-0.2	0.2	0.6	0.7	1.0	1.7	1.8	2.1	2.1	2.0
10. Other manufacturing	1.7	2.2	2.6	2.7	3.0	3.7	3.8	4.1	4.1	4.0
11. Electricity, gas and water	1.0	1.4	1.8	1.9	2.2	2.9	3.0	3.3	3.4	3.2
12. Construction	1.1	1.5	1.9	2.0	2.3	3.0	3.1	3.4	3.4	3.3
13. Trade	0.7	1.1	1.5	1.6	1.9	2.6	2.7	3.0	3.0	2.9
14. Hotels and restaurants	0.7	1.1	1.6	1.6	1.9	2.6	2.7	3.0	3.1	2.9
15. Transport	1.2	1.6	2.0	2.1	2.4	3.1	3.2	3.5	3.5	3.4
16. Post and communication	0.8	1.2	1.7	1.7	2.0	2.7	2.8	3.1	3.2	3.0
17. Financial services	0.8	1.2	1.7	1.7	2.0	2.7	2.8	3.1	3.2	3.0
18. Public and other services	0.3	0.7	1.2	1.2	1.5	2.2	2.3	2.6	2.7	2.5

To evaluate the impact of the oil boom on poverty and inequality indicators we multiply the 2002 micro-household budget survey data by the changes in consumption from Table 5.4. For this purpose both poverty and inequality were calculated using expenditure statistics. A change in indicators can occur both from within as well as from between household types. The former will depend on the consumption pattern of each household whereas the latter on which income group household belongs to.

Table 5.5 shows standard poverty and inequality indicators before and after the shock.[40] There was only a small change in expenditure inequality towards being more unequal, the Gini coefficient increased from 32.2 to 32.5, so did other indicators. This could partly be the result of a proportionally bigger increase in consumption for the rich households. On the other hand, there was more than a 1 percentage point reduction in the poverty headcount index, from 15.6 to 14.5 percent of the total population. In the period from 2001 to 2005 an actual poverty headcount was falling on average by 2.6 percentage points. Therefore in the absence of demand from the oil sector it would have been only 1.5 percent. However, it is not possible to conclude that the effect of the oil demand shock is pro-poor as a poverty gap and poverty severity (P(1) and P(2)) did not change much. Rather it seems that the poor benefited from the general economic upturn more or less equally with other income groups. This conclusion is only tentative and to some extent depends on the transmission mechanism for the shock (from CGE to micro-data).

Table 5.5. Impact of Oil Boom on Poverty and Inequality Measures

		Base (2002)	After shock
Inequality	GE(-1)	20.4	20.9
	GE(0)	17.3	17.6
	GE(1)	17.8	18.1
	GE(2)	22.6	23.0
	Gini	32.2	32.5
Poverty	P(0)	15.6	14.5
	P(1)	3.8	3.5
	P(2)	1.4	1.3

5.5. Conclusions

Classic models of energy based development such as the Resource curse and the Dutch disease model imply that an expansion of primary exports has a negligible effect on the growth of non-export GDP (for example, Fosu 1996), significantly increases income inequality, crowds out other non-mineral exports via exchange rate appreciation and generally cripple the economy in the long run. Kazakhstan's experience, however, better fits the Northian framework, where demand from the booming primary industry drives

[40] Please see the section A.2 of the Appendix A for the definitions of poverty and inequality indicators used.

production in secondary and tertiary industries and allows them to expand the export base in the future (for example, the financial sector).

Kazakhstan's economic development since 2001 has been accompanied by rapidly growing oil prices and an expanding oil and gas production. Although practically all scholars agree that the oil sector was pivotal in sustaining an impressive double digit GDP growth, exactly how it affects other sectors and the economy was not studied. On the contrary, the official statistics suggest a rather modest share of the oil industry in the GDP. This study analysed Kazakhstan's economic transition since gaining independence in 1991 until present when it emerged as a regional leader in terms of economic development. Using the multi-sector, multi-household CGE model the average annual demand created by the oil industry was simulated. The results imply that 40 percent of the actual GDP growth since 2001 was due to the oil sector. Those industries that have strongest intersectoral links with the oil sector benefit most, for example, construction and financial services. At the same time those industries competing for the same factors and intermediate inputs, such as other mining, would have been growing faster if there was no demand from the oil sector. Some exchange rate appreciation created by the increased export revenues has overall positive impact via cheaper imports for import-intensive producers and final consumers and via extra domestic demand stimulus. As the simulation demonstrates, although the oil expansion contributes about 38 percent annually to poverty reduction, the poor benefit on the same par with the rich, since inequality does not change significantly nor does the severity of poverty.

CHAPTER 6

What is the Real Size of the Oil Sector in Kazakhstan? How transfer pricing should not, but does, affect the structure of GDP.

6.1. Introduction

It has often been stressed that the value added share of extracting industries is underestimated in the official statistics of resource rich transition countries. There might be different reasons for this, for example in the case of Russia and Kazakhstan the problem of transfer pricing might be the main cause. Another reason is that the authorities, for various political reasons, may want to make the economy look more diversified and less dependent on the revenues from one sector than it really is. It is possible that countries simply would not want to change the established methodology for the sake of time consistency. This paper develops an analytical framework based on the SUT and IO tables to address the distortions in official statistics caused by the widespread practice of transfer pricing in Kazakhstan's oil and gas industry. The problem addressed by introducing some adjustment to the trade margins and using basic accounting identities to other related statistics. Generally, in cases where the trade margin is identified correctly, but treated differently than the UN statistics recommend, the adjustment to the value added is an appropriate response to the change in trade margins.

In the 2005 World Bank Country Economic memorandum for Russia, Schaffer and Ruhl (2005) questioned the published GDP structure of the Russian economy. They stress that according to the official statistics, in Russia in 2000, production of services accounted for 49 percent of GDP, whereas production of goods accounted for only 40 percent. Within services, trade represented nearly a quarter of GDP with about half of all profit in the economy. At the same time oil and gas industry was responsible for only 8 percent of GDP. This seemed a little anomalous as export revenues alone, from the oil and gas sector were about 20 percent of GDP (op. cit.). The problem was in the transfer pricing practices exercised widely in Russia. When an appropriate adjustment was introduced, the GDP share of the oil and gas sector increased by 11 percent mostly at the expense of trade sector which went down by 13 percent.

Similar issues arise in other energy rich transition economies, in particular in Kazakhstan. The value added share of the oil and gas sector was only 8.5 percent in 2001 with oil dominating the export and industrial output. Export revenues from the oil and gas sector amounted to 21 percent of GDP in 2001. Based on the findings of Schaffer and Rule (2005) we develop an analytical framework for the adjustment required to the statistics distorted by the transfer pricing and further apply it to Kazakhstan.

Thus, first we provide some background on the concept of SUT and IO tables as well as on different price valuations within this system. Having completed that, we proceed by developing the formal adjustment framework and give some intuition behind it. For practical applications, data and calculations required for the adjustment can be greatly reduced in some cases. Consequently, a simplified version of adjustment will be discussed after the complete analytical framework is in place. The following section shows numerical example on the case of Kazakhstan and Russia and discuses some of its implications for the economic structure. Finally, using a CGE model and scenarios from Chapter 5 we test how transfer pricing in the energy sector in Kazakhstan can affect the results of economic modelling based on this data. The last section concludes on the analysis.

6.2. Supply and Use Tables and IO

The Supply and Use tables are one of the key building blocks in the System of National Accounts. It is a statistical tool, in which the relationships between flows of goods and services and components of the value added are established in neat table form. The fundamental assumption used in the construction of these tables is equality between total supply and total use of resources. In practice, tables are normally rectangular with industries along the columns and goods along the rows.

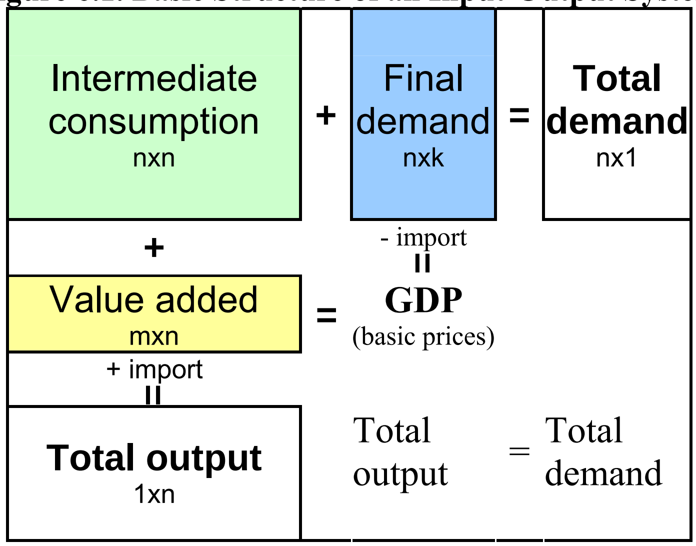
A supply table along the rows shows the origin of each product in the economy and the total sum represents the total supply of each product. Take for example the production of electricity, you would expect that besides the actual industry whose primary activity is electricity production, many other industries on different scale would engage in some electricity generation (usually for own use). Thus, electricity as a product appears in many cells along the row in the supply table representing the generation of electricity by corresponding industries. On the other hand, there are probably not many industries outside the mining sector producing oil. In such a case the only non-zero elements in the row representing oil product would be cells corresponding to the mining industries (columns), not taking the imports column into account. Reading the supply table along the rows is also useful, in identifying the links between domestic production and imports of certain commodities.

In a similar way, the columns in the supply table represent output by industries. In the same way a single product can be produced by several industries, a single industry can produce more than one product. The composition of output of an industry recorded along the columns of the supply table and the sum of a column represents the total value of production by that industry.

The Use table records utilisation of products by industries and final consumers. It also shows the value added, which is derived as a difference between the value of total industrial output and the total value of intermediate consumption. Along the columns the Use table contains information on the cost structure of the production of industries as well as the value added generated. Rows of the table contain information on how a product is used. The Use table consists of three parts: The table of intermediate demands; The table of final demands and the table of value added (see Figure 6.1 below).

The table of intermediate demands records the consumption of goods and services by industries for intermediate use. These products are fully consumed or transformed in the production process. In other words this table reflects the cost structure of production. The table of final demands shows the division of products into final consumption (including government consumption), investments and exports, sum of which gives the final demand measure of the GDP. Finally, the table of value added contains information on wages, profits and taxes on production paid/received by the industries and the total of this table is also equal to the GDP.

Figure 6.1. Basic Structure of an Input-Output System

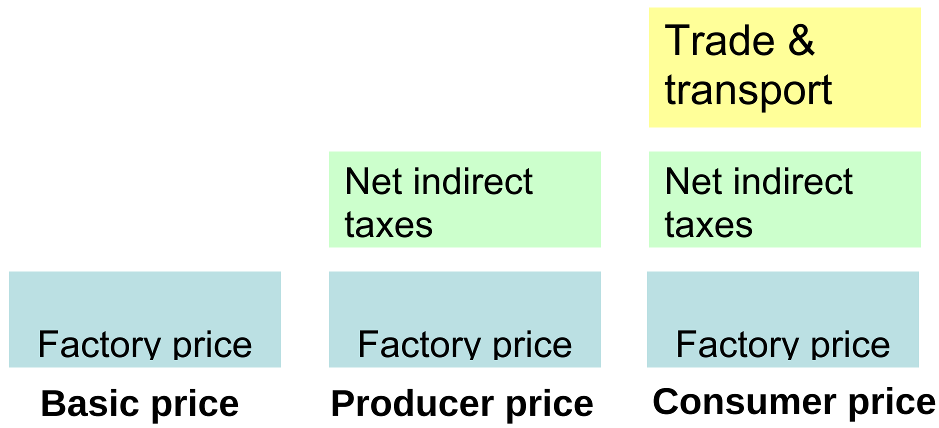


The Input-Output system is based on the Supply and Use tables (see Figure 6.1). It has exactly the same structure as a Use table with the only one difference – while a Use table is generally rectangular and records products along the rows and industries along the columns, the IO table is square and symmetric in the sense that it is constructed as either industry-industry or product-product version of the Use table. In the industry-industry version (which is the most common representation of IO), rows record output of industries (which could be several products produced by one industry) and the sum of a row represent the total uses corresponding to the industry's output. The meaning of the columns is the same as in the Use table and as before, it defines the cost structure and value added of an industry.

6.3. Price Valuation

Three price valuations are distinguished within the SUT and IO framework depending at which stage, from producers to final consumer, output is measured. The price paid by the final consumer is generally different from the price received by the producers due to the presence of taxes, transportation costs and trade commissions.

Figure 6.2. Price Types in the National Accounts



The basic price is the price retained by producers, the so called factory price or value of the good/service to the producer. It excludes all taxes, which are eventually transferred to the government, but includes any subsidies. It also excludes any transport charges or trade commissions. The producer price is the price received by producers for a unit of good sold or services rendered. This can be considered as the price paid at gate of the factory. It includes any taxes invoiced to the purchaser less subsidies, but it excludes any transportation charges or trade commissions. The consumer price is the final price paid by the buyer including taxes trade and transport charges but excluding deductible VAT or similar taxes, and subsidies.

Different products incur different taxes, transportation costs may vary significantly from one product to the other. Similarly, the same product may go through a number of intermediaries, each of which potentially charges a margin, before reaching the final consumers. Because of these reasons, the basic price is more homogenous than the producer price, which instead is more homogeneous than the consumer price. “Since the same goods and services can be measured differently in the market and since homogeneity is one of the most important underlying assumptions of input-output economics, the SNA recommends that products are measured as homogeneously or uniformly as possible in the

SIOT, preferably in basic prices. When that is not possible, they can be valued at producers' prices instead".[41]

6.4. Adjustment – Technical Description

Having explained briefly the concept of SUT and IO tables as well as difference between possible price valuations within this framework we can proceed to outline algebraic formulation of the adjustment procedure used in this study. The formal framework will be developed based on the IO system; however possible modifications and simplified version of the procedure will also be discussed. All notations and variables' definitions can be found in the section E.1 of the Appendix E.

Adding all elements of the IO system in basic prices along the rows we get total demands:

$$\sum_{j=1}^{n} x_{ij}^{b} + y_{i}^{b} = z_{i}^{b} \tag{6.10}$$

Similarly, adding all elements of the system along the columns we get the total value of output of corresponding industries:

$$\sum_{i=1}^{n} x_{ij}^{b} + \sum_{i=1}^{n} t_{ij} + v_{j} = z_{j}^{b} \tag{6.11}$$

The fundamental accounting identity in this case is that total demands for products should be equal total amount produced domestically and imported (assuming for simplicity that imports are equal to zero):

$$z_{i}^{b} = z_{j}^{b}, \text{ for all } i = j \tag{6.12}$$

[41] UN, (1999) "Handbook of Input-Output Table Compilation and Analysis". Series F, No 74, United Nations, New York., page 56.

To translate this system into the consumer price representation one needs to add indirect taxes and trade and transport margins and subtract subsidies on products from intermediate demand and final demand components. Note that after these adjustments, the identity (6.12) will not hold since column sums z_j^b will not change, whereas row sums from z_i^b will change to z_i^c (assuming that taxes are on the net basis):

$$\sum_{j=1}^{n} x_{ij}^c + y_i^c = z_i^c \tag{6.13}$$

, where $x_{ij}^c = x_{ij}^b + trd_{ij} + tran_{ij} + t_{ij}$ and $y_i^c = y_i^b + trd_i^y + tran_i^y + t_i^y$

One important clarification regarding the transport and trade margins should be made at this point. The basic price representation includes trade and transport margins as output of trade and transport sectors correspondingly. However in consumer prices, the output of trade and transport sectors includes only the direct services provided by them, whereas margins are allocated to the output of products where it has been generated. This is why the transition from basic to consumer prices does not change the values of industrial output (the column sums). Accordingly, when we perform the transformation from basic to consumer prices we add corresponding margins to sectors of origin and subtract exactly the same amount from trade and transport sectors and vice versa when we go from consumer to basic prices (see the schematic representation of trade margins matrix below for further clarification).

$$M = \begin{pmatrix} trd_{11} & \dots & trd_{1n} \\ \vdots & & \vdots \\ trd_{k1}^{trade} = -\sum_{i \neq k} trd_{i1} & \dots & trd_{kn}^{trade} = -\sum_{i \neq k} trd_{in} \\ \vdots & & \vdots \\ trd_{n1} & \dots & trd_{nn} \end{pmatrix} \; - \; \begin{array}{l}\text{Trade margins on} \\ \text{intermediate demand}\end{array}$$

Thus, (6.11) can also be rewritten as:

$$\sum_{i=1}^{n} x_{ij}^{c} + v_{j} = z_{j}^{b} \tag{6.14}$$

In short, the adjustment procedure involves changing the matrix of margins, as expressed in shares of total resources in consumer prices, thus changing the output of product in basic prices (row sums). Because in basic prices the equality (6.12) must hold and the column sums of the intermediate demands matrix are unaffected by the changes in the margins due to their structure, the corresponding adjustment will be made to the value added component of the IO system to reconcile the difference. More formally:

Given (6.13) we have

$$\sum_{j=1}^{n}\left(x_{ij}^{c} - trd_{ij} - tran_{ij} - t_{ij}\right) + \left(y_{i}^{c} - trd_{i}^{y} - tran_{i}^{y} - t_{i}^{y}\right) = z_{i}^{b} \tag{6.15}$$

On the other hand, from (6.14) we can derive that:

$$z_{j}^{b} - \sum_{i=1}^{n} x_{ij}^{b} - \sum_{i=1}^{n}\left(trd_{ij} + tran_{ij}\right) - \sum_{i=1}^{n} t_{ij} = v_{j} \tag{6.16}$$

Now, if transport or trade margins are modified it would not affect the equation (6.16) due to reasons explained above, however the identity (6.12) would be violated. To correct that and restore the IO structure we find the new value added v_j by substituting expression for z_i^b from (6.15) into (6.16), therefore for all $i = j$ we have:

$$\begin{gathered}\left(\sum_{j=1}^{n}\left(x_{ij}^{c} - trd_{ij} - tran_{ij} - t_{ij}\right) + \left(y_{i}^{c} - trd_{i}^{y} - tran_{i}^{y} - t_{i}^{y}\right)\right)_{i=j} - \\ \left(\sum_{i=1}^{n} x_{ij}^{b} - \sum_{i=1}^{n}\left(trd_{ij} + tran_{ij}\right) - \sum_{i=1}^{n} t_{ij}\right)_{i=j} = v_{j}\end{gathered} \tag{6.17}$$

Given that we now have a formal outline of the methodology we can provide the more general intuition behind it.

Margins in the system of national accounts form part of the output of the sector which provides the corresponding services (e.g. trade margins form part of the trade sector output, transport margins are part of the transport sector output etc.). For example, if the final market value of a barrel of oil is 100 dollars this does not represent the value of the output of a barrel of oil for the oil industry. In the first place it has to be transported and the cost of this transportation is treated as a transport margin and eventually recorded as the output for the transport sector. Then, wholesale or retail traders retain part of the 100 dollars value as their commission, which is then recorded as an output of the trade sector. Even though it was the oil product that generated the 100 dollars, only part of it goes directly to the value of output of this product. Therefore, if margins represent significant share of output and GDP, incorrect treatment or misplacement of margins may considerably alter the sectoral output structure and make international comparison less meaningful.

The example of the oil industry was not chosen at random. Most developed mineral rich countries such as UK, Canada, Norway etc., treat trade margins on extraction of natural resources as output of corresponding extracting industries. This means that the trade margin in these counties on oil and gas production is zero or very small relative to the output. In this case, if a country reports significant trade margin on mineral extraction, which will eventually be allocated to the output of the trade sector then output of extracting industry in this country will be underestimated and trade sector will be inflated compared to the standard treatment used by most developed countries. Such mistreatment of trade margins is profound in the system of national accounts of some of the energy rich transition countries, namely Russia and Kazakhstan. Thus, the adjustment described above is required first of all to put these countries on the same basis for the possibility of cross-country comparison.

By changing the composition of margins we change the composition of output too. So that if value of output of an oil industry was 70 and trade margin was 30, we subtract 30 from the trade sector and add it to the output of the oil industry. Thus, value of output of trade industry is reduced by 30 and value of output of oil industry is increased by 30, whereas trade margin on oil is made equal to zero in this example.

The adjustment of margins should change the structure of the value added as well as output. According to SNA, gross value added of an industry is calculated as the difference between the industry output in basic prices and the intermediate consumption in consumer prices. The value of intermediate consumption for any industry would not change when margins are changed, because whenever we add to an extracting industry we subtract the same amount from the trade industry. If before for example, agriculture consumed 5 units from oil industry and 10 from trade (15 from the two), now it would consume 10 from oil and 5 from trade, so the total is unaffected. If intermediate consumption and imports are unchanged then in order to have equality between the output of an industry and demand for products of this industry, value added needs to be adjusted to correspond to the new demand and hence output structure.

6.5. Adjustment – Technical Description Matrix Form

When possible it is often easier to work with a matrix formulation of the problem. Given the notation in the section E.1 of the Appendix E, we can write down the vector of total demands represented by the row sums as:

$$X^b.E + Y^b = Z^b \tag{6.18}$$

Using the definition of basic price, we have:

$$\left(X^c - M - R - T\right)E + \left(Y^c - M^y - R^y - T^y\right) = Z^b \tag{6.19}$$

On the other hand, noting the identity (6.12), column sums of the I-O system equal:

$$X^{b'}.E + T^{'}.E + V^{'} = X^{c'}.E + V^{'} = Z^b \tag{6.20}$$

Solving for V:

$$Z^b - \left(X^{b'} + M^{'} + R^{'} \right) E - T^{'}.E = V^{'} \tag{6.21}$$

Now if we substitute, in equation (6.21) expression for Z^b from equation (6.19) we establish the relationship between margins/taxes on products and the value added – equation (6.22). Changing the margins would change the sectoral composition of the value added but not the total.

$$\left(X^c - M - R - T \right) E + \left(Y^c - M^y - R^y - T^y \right) - \left(X^{b'} + M^{'} + R^{'} \right).E - T^{'}.E = V^{'} \tag{6.22}$$

6.6. Recovering Matrix of Margins

For some countries, detailed information on margins is not available. In this case, often instead of matrices such as M and M^y, only a column of total margins on products is available , which is equivalent to $(M + M^y).E$. This column, along with the column of total indirect taxes on products, allows to show the transition of Supply table from basic to consumer prices. For the adjustment as described above, we need complete matrixes of margins on intermediate and final demand. To construct these detailed margins from totals we employ an assumption that the value of trade and transport margins is proportional to the value of product where the margins are generated. Effectively we are assuming that products of the same industry would have the same margins, proportional to the products' value, irrespective which industry consumed these products or whether it is exported or invested. Algebraically it can be formulated as follows:

We know that

$$Z^b + M^{total} + T^{total} = Z^c \tag{6.23}$$

Where M^{total} and T^{total} are the column vectors of total margins and indirect taxes on products. We construct an n x n diagonal matrix D of margin shares with only nonzero elements along the main diagonal $d_{ij}\big|_{i=j} = \frac{m_i}{z_i^c}$, where m_i is the element of the vector M^{total} of total margins. Given this construction, for example for trade margins we can derive that:

$$\begin{aligned} D.Z^c &= M^{total} \\ D.X^c &= M \\ D.Y^c &= M^y \end{aligned} \tag{6.24}$$

One exception to this construction is the trade sector, in the case of trade margins or transport sector when transport margins are considered. The margins' share of trade/transport sector is set to zero in the matrix D and when the original matrix of margin values is restored by multiplying by D the trade sector margins are obtained by summing all the elements in the column, and adding the minus sign.

6.7. Simplified Version of Adjustment

One interesting implication follows from the analysis above, namely that only totals by products or by industries matter if we are not interested in how the structure of the intermediate demand or final demand would change in the result of the adjustment, but only concerned about the value added structure. In this case a shortcut can be used, which can greatly simplify the adjustment procedure and significantly reduce the amount of data required for it.

Depending on the available data, we suggest two different approaches. First, if we have industry by industry IO tables for the country of interest and total columns of margins by industries' products for benchmark countries we can generally follow the procedure as above with one simplification. In this case, we only need the total column of resources in consumer prices (row sums) and only the total column of margins, all by industries' products. The change in the column total margins would translate one to one to change in total resources. Since the latter should be equal to the total output of industries, the value added will change by exactly the same amount to ensure that. Hence the change in total resource structure due to the change in margins directly translates to the change in the value added. But for this, we need symmetric IO tables for the country of interest as well as margins by industry products of benchmark countries, which are not readily available.

The second approach assumes that we have Supply and Use tables for the country of interest and only the total column of margins by products (not by industry products), which are relatively easy to obtain. The first step is the same, change in margins translates into change in total resources, however Supply and Use table are not symmetric and we do not have such link as with IO tables. In order to translate it into the change in output by industries and hence change in value added, we make use of the Supply table and some additional assumptions. Specifically, we assume that any change in the production volume of a product is the result of proportional change in production of this product by all industries producing it. In other words, we assume that if the total supply of electricity increases, all industries producing electricity increase production of it proportionally to their share of total supply. Thus, new output by industries is simply the column sums of this new Supply table, which correspond to the new column of total products supply. And as before change in output directly translates to change in value added since total intermediate consumption by industries is unaffected.

Both approaches produce similar results since usually major share of a product is produced by its parent industry anyway. Essentially the difference between the two is that in the first approach, due to the symmetric nature of the IO table, change in the supply of a product translates one-to-one into change in output of its parent industry, whereas in the second case, there is an adjustment for other industries that produce the same product.

6.8. Data Description

One of the aims of this study is to compare the treatment of the energy sector in emerging economy such as Kazakhstan to that in developed countries. Several OECD countries have been chosen based on the availability of data and the following factors: a country should be a significant energy exporter/producer; a country should have certain geographic and climatic features. Thus we selected two OECD countries: Canada and Australia. It should be noted that Norway, UK and Netherlands were also considered. Results for these latter set of countries follow the general pattern, but they are not reported here since we were not able to obtain transport and trade margins separately.

Countries usually use different industrial and product classifications; however, it should generally be possible to match country specific classification to the UN standard industrial classification. Hence the ISIC Rev 3.1 at the top two levels of aggregation (tabulation categories and divisions) was chosen as a standard to which all other country specific classifications were matched.

Kazakhstan

We employed Supply and Use tables for 2001 and 2005, produced by the Statistical agency of the Republic of Kazakhstan. Some aggregation had to be made to bring tables to a common industrial classification as there are minor differences between those years. The final set of tables has 56 sectors and generally follows ISIC Rev 3.1 classification.

Canada

Data on margins and supply obtained from the Statistics of Canada website and CANSIM for the year 2000 at the disaggregation level M (103 sectors) are based on The North American Industry Classification System (NAICS).

Australia

Supply and Use tables as well as detailed tables of margins are publicly available from the Australian Bureau of Statistics – Australian National Accounts: Input-Output Tables - Electronic Publication, catalogue number 5209.0.55.001. Data for 2002 are based on the Australian and New Zealand Standard Industrial Classification (ANZSIC) and contain 109 sectors.

6.9. Results

In this section we present some results of applying Canadian and Australian trade margins to Kazakhstan. The emphasis will be placed on the primary energy sector (the extraction of oil and gas), while other industries will be discussed only briefly. Most OECD energy producing countries follow the similar pattern in that trade margins in the energy sector are practically zero. However in Kazakhstan it was about 23% of the total domestic production of oil and gas in 2001 and 9% in 2005. Table E.1 in section E.2 of the Appendix E shows shares of trade margins in total domestic production for Kazakhstan, Australia and Canada. While in practically all these countries trade margins in the energy sector are very small in relative terms, other industries such as agriculture and manufacturing do not agree across countries that precisely. For example, in Australia in 2002 the trade margin share of domestic production of metals was 17% compared to 8% in Canada in 2000 and 22% in Kazakhstan in 2001. Such irregularities, to a various extent, persist throughout manufacturing industries in different OECD countries for different years. One of the reasons is perhaps that manufacturing is generally much less homogeneous than the extraction of oil and gas and hence unlike in the energy sector, the trade margin's pattern in manufacturing may vary from year to year from country to country. Hence, while these countries provide a good indicator of what the energy trade margin should be, they should be used with caution for the analysis of manufacturing and agricultural sectors.

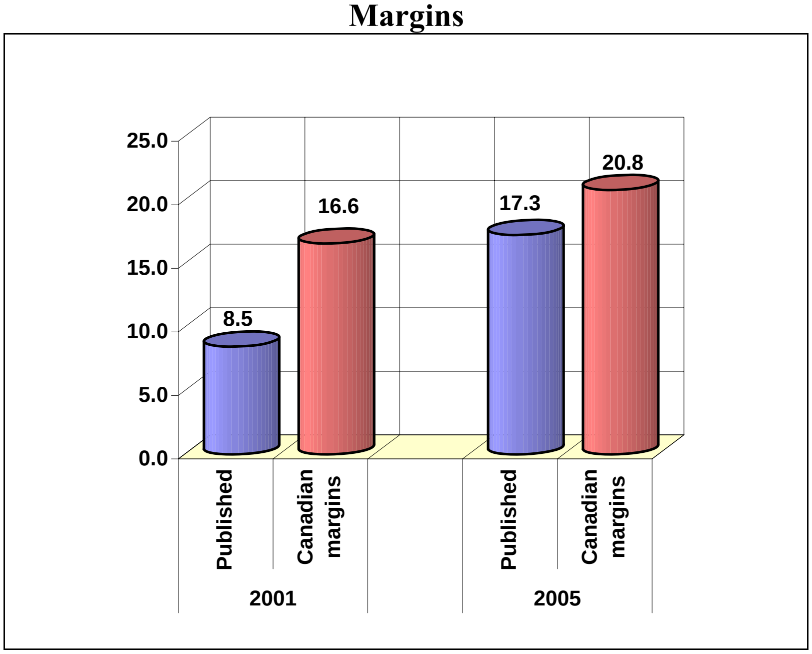
There are two explanations for the large energy sector trade margins in Kazakhstan:

1. **Transfer pricing**. Currently, ninety percent of produced oil in Kazakhstan is exported. It is a widespread practice for an oil company to sell its products abroad at lower than the market prices via trading subsidiaries. In terms of national accounts it means that some profits are shifted from the extracting industries to the trade sector hence reducing the value added of the energy sector and inflating the trade sector.
2. **National statistics practices**. While the transfer pricing in the energy sector might exist to a different degree in many OECD countries, it is treated consistently by the national statistical offices. As was already noted, these countries follow a similar patter of close to zero trade margins on the extraction of oil and gas. In Kazakhstan however, it seems that no special adjustment for transfer pricing is being performed, hence the international comparison could be misleading.

Applying Canadian and Australian trade margins structure shifts some of the value added from the trade sector to the energy sector. In 2001, the value added share of the oil and gas sector in Kazakhstan was 8.5 percents, recalculating it using Australian margin increases the share by additional 7.6 percentage points to 16.1 percents of the total value added. Applying Canadian margins increase the share by 8.1 percent that is almost double the officially published number (Tables E.2 and E.3 in the section E.2 of the Appendix E). Thus, when adjusted for transfer pricing, the energy sector in Kazakhstan in 2001 accounted for about 16.4 percent of the economy instead of 8.5 percent reported by the official statistics. At the same time the value added share of the trade sector in 2001 was down by 10 using Australian margins and 11 percentage points in case of Canada, which is a reduction from 12.8 to a mere 2.8 and 1.8 percent accordingly, thus reducing the share of services and increasing the overall importance of the industry.

In 2005 trade margins are significantly smaller and account for only 9 percent of the oil and gas output, however value added share of this sector is now 17.3 percent. Recalculating value added, applying Australian and Canadian margins increased the share by 3 and 3.5 percentage points accordingly making it approximately 20.5 percent of the total. The change in the value added after adjustment is noticeably smaller in 2005 than in 2001, while the adjusted value added shares are more similar in 2001 and 2005.

Figure 6.3. Value Added Share of the Oil and Gas Sector using Canadian Trade Margins



Comparisons across the results for these two years suggest an interesting conclusion. It seems that Kazakhstan's national statistics are gradually introducing corrections to the treatment of trade margins in the energy sector. For example in 2002 the trade margin in the energy industry accounted for 17.3 percent of the output, which falls between 2001 and 2005 value. The most recent IO table available at the time of writing this chapter is for the year 2006 and it shows that the share of the oil and gas sector is smaller than in 2005 and amounted to 7.6 percent of total output. It is expected that more recent data will show a close to zero trade margin on energy as it is in most of the OECD countries and hence even an greater increase in the value added share of the extracting industry. In addition, according to the published data, the value added share of the oil and gas more than doubled between 2001 and 2005 (from 8.5% to 17.3%) however, taking into account adjustment for transfer pricing the increase was only half of that (from 16.4% to 20.5%) and represented a rise by a quarter.

Other industries also provide evidence for the changing structure of the trade margins. There are no margins for services and also construction and electricity production in OECD country statistics. However, in 2001 the trade margin in construction and electricity production in Kazakhstan accounted for 16% of total output each (see Table 6.1). In 2005 however, both of these values are zero, while most other sectors manifest larger trade margin shares than in 2001.

Taking this argument further suggests that the dramatic increase in the GDP share of oil and gas happened at the earlier stage of Kazakhstan's economic recovery than implied by the official statistics. This industry was one of the first to recover from post-soviet economic decay and was growing rapidly after the 1998 financial crisis. Its share in total industrial output has almost doubled between 1998 and 2002 from 23 to 40 percents. Therefore, the contribution of the oil and gas into country's recent impressive economic performance would have been significantly bigger than estimated by the national statistics using the published value added structure. This narrows the gap between the widely discussed dependence of Kazakhstan's economy on the extraction of natural resources and relatively undersized value of this industry in the national statistics.

6.10. One Implication for Economic Modelling

Finally, there is an interesting issue of what implications the adjustment for transfer pricing described above would entail for the results of economic models that use some components of Input-Output tables such as CGE or Input-Output models. It is reasonable to assume that the bigger the relative size of the industry in an economy the bigger its overall impact would be. However, the adjustment involves the redistribution of economic activity; hence an increase in the size of the oil sector unequivocally leads to the reduction in the size of the trade sector. The final outcome depends on the structure of the economy or more precisely, whether the loss of the second order impact of the trade sector is greater or smaller than the gain in the first order impact of the oil sector. Since Chapter 5 is concerned with estimating the economy-wide impact of the oil industry we will repeat the same scenario as in Chapter 5, but use an adjusted Input-Output table to see how exactly it would affect the results. The employed CGE model uses a SAM which embodies the 2002 official (unadjusted) Input-Output tables. The Input-Output data in this SAM will need to be replaced with the new (adjusted) tables. The trade margin in 2002 amounted to 18 percent of the total domestic output (see Table E.1. in the section E.2 of the Appendix E). Since we are mostly interested in the oil industry, we do not change trade margins for other non-energy sectors (unlike in the examples in this study) and only assume that instead of 18 percent of output that the margin in the oil and gas sector is now zero. All subsequent adjustments to the 2002 I-O tables are as described in this study. Applying the Canadian trade margin structure entails a 6.7 percentage point increase in the value added share of the oil and gas sector in Kazakhstan (from 12.7 to 19.3). The value added of the trade sector decreased by the same 6.7 points accordingly from 12.3 to 5.6 percent of value added.

The base scenario in Chapter 5 involves an 18 percent exogenous increase in the export of oil, which corresponds to the 5 year real average growth of the oil export between 2001 and 2005. The results show that on average between 2001 and 2005, 4 out of 10 percent of GDP growth was due to the oil sector. Selected results of repeating the same scenario, but using the adjusted for transfer pricing Input-Output table and the SAM instead are reported in Table 6.1. along with the original results.

Table 6.1. Macro-results of the CGE Model with Adjusted and Unadjusted Input-Output Tables (% change).

	Unadjusted	Adjusted
Oil Output	12.5	11.7
Total Domestic Output	3.0	3.6
Public Spending	6.1	7.1
Private Spending	2.9	3.8
Export	5.4	6.6
Import	5.5	6.7
GDP	4.0	5.2
Real exchange rate (- means real appreciation)	-0.9	-1.0
Real wage	1.8	2.2

One can see that the results are similar to the original ones with the oil sector spillover being more profound when the adjusted Input-Output tables were used. Since the absolute value of the output of oil is greater in the adjusted table, the relative increase to support an 18 percent export rise is smaller. All other macro-variables however experienced a bigger positive boost in the adjusted case compared to the case when official data were used. When transfer pricing has been appropriately accounted for in the national statistics, estimated contribution to the GDP growth of the oil industry could be as high as 5.2 percent annually out of a 10 percent average annual growth over the studied period.

6.11. Conclusions

Transfer pricing if not dealt with appropriately may significantly distort the GDP structure. This problem is especially evident in the oil and gas industry in Kazakhstan. This paper developed a framework that allows the adjusting of the GDP structure distorted by the transfer pricing when it was not carried out by the national statistical agencies. The data required for the adjustment are the SUT and IO tables, which are available from the national statistical offices. Moreover if one is interested only in the value added structure the amount of calculations and data can be reduced greatly. Results for Kazakhstan show that the value added share of the oil and gas sector in 2001 was significantly underestimated. In 2005 the correction is smaller and suggests a gradual improvement and implementation of internationally accepted practices in Kazakhstan's statistics. The higher value added share of the energy industry means a bigger contribution from this sector to the post-soviet economic recovery and recent high levels of economic growth than that implied by the official statistics.

CONCLUSION

Chapter 1 provides economic background of Kazakhstan since the collapse of the FSU and subsequent gain of independence in 1991 with focus on the energy sector. Since then, the importance of the oil and gas industry for the economy has been growing rapidly. By 2007 the level of oil output tripled reaching 1.5 million barrels per day and the share of the oil in total industrial output reached 50 percent compared to 2 percent in 1990. In 2008 oil and gas accounted for about 70 percent of all Kazakhstan's export compared to 9 percent just before the Soviet collapse. At the same time, GDP and living standards of the population were rising rapidly in more recent years, thus making the Resource Curse arguments irrelevant in Kazakhstan's case. When transition started, without heavy subsidies and artificial trade links that prevailed in the Soviet era most firms appeared internationally uncompetitive. Those firms had to close or restructure and by the time Russian financial crisis of 1998 was over, the oil and metals industries emerged as virtually the only internationally competitive sectors.

The aim of Chapter 2 is to provide a background for construction of a CGE model and a review of existing literature on the subject. The first chapter also defines the area of the model application. It highlights theoretical foundation, general structure and some interesting findings of the previously conducted studies that employed CGE modelling technique. Modern CGE modelling tool has a long history of development. It gradually progressed from purely theoretical concepts developed by Debreu (1959) to a powerful applied tool first pioneered by Scarf (1967) and later extended by Johansen, Shoven, Taylor and others. In the present day, when computational ability is growing exponentially the CGE apparatus presents a unique tool in which various economic forces can be contained and analysed in a consistent economy-wide framework. Chapter 2 established how CGE models are effectively applied to cases in energy economics and economics of transition countries. It concluded, however, that CGE studies are more likely to influence policy decisions when their results are supported by alternative modelling techniques and analysis. Kazakhstan's economy is rather underrepresented in the general pool of CGE studies, and those few papers which do exist focus on the impact of trade liberalisation and Dutch Disease in the form of exchange rate appreciation where the latter studies concur that real appreciation is inevitable in the presence of oil windfall revenues, although policies aimed to restrain it may prove to be counterproductive.

Chapter 3 developed a small CGE model for the analysis of minerals-driven economic growth in Kazakhstan. It discussed all aspects of building a CGE model such as the fundamental assumptions, the derivation of model equations, the estimation of parameters and model balancing. The extensions to the basic model in Chapter 3 include several household types and multiple closure rules which allow for poverty and inequality analysis and bring some long run features to an essentially static framework. The structure of transactions within the model closely resembles the Kazakhstan's SAM constructed in Chapter 4.

Consequently, the construction of a SAM for Kazakhstan is described in Chapter 4. The chapter has two main objectives. First, it develops an appropriate dataset for the CGE model in Chapters 3 and 5. Second, it provides a general framework for building a SAM based on the 1993 UN system of National Accounts and Input-Output tables. A SAM is a snapshot of the whole economy over a certain period of time. A detailed and carefully constructed SAM can be a valuable tool for policy analysis. The chapter begins with building a macro-SAM using primarily the national accounts data. Detailed references to the standard 1993 UN national accounts source ensures that it can be easily replicated for other periods and countries. At this stage the SAM has only one production sector and a single representative household. Therefore, the second step involves matching the Input-Output tables and household budget survey data with the macro-SAM entries. Finally, various sources are combined in a micro-SAM using a powerful optimisation procedure, which allows to efficiently remove all potential inconsistencies between the different data sources. The acquired micro-SAM represents a detailed reflection of the Kazakhstan's economy in 2002. It is fully consistent with published national accounts and has 57 sectors, 10 household types (cohorts defined according to their income) and complex tax and transfer structure. Finally, the chapter describes what adjustments are necessary for the SAM to be compatible with the CGE model.

Chapter 5 analyses the role of the oil industry in Kazakhstan's economy. Recent Kazakhstan's economic development fits the framework developed by North (1955). High revenues and demand generated by the highly successful industry, which exports goods or services help to maintain a high level of spending and investment, and, as a result, sustain domestic production of a wide range of services and goods. Those tertiary industries, in turn, has a potential to expand internationally in the future as in the case of the banking sector.

The results of the CGE simulations imply that since 2001 the oil sector contributed about 40 percent of total GDP growth. In other words, the oil industry generated 4 out of 10 percent average GDP growth in Kazakhstan between 2001 and 2005. If there was no oil industry, Kazakhstan's economy would have performed worse than most transition economies which do not have rich energy resources. This estimate is more substantial than the one presented by the IMF (2005) study, which estimated broad oil sector contribution to GDP growth at 3 percent. Financial services and construction have strong links with the oil industry and benefit most from its expansion while other mining industries and some manufacturing are among sectors which would have been better off without it, as they essentially compete for the same resources and do not enjoy the additional demand created by the oil sector.

Increased oil export revenues have put an upward pressure of about 1 percent annually on the real exchange rate. However, running the same simulation while holding the real exchange rate fixed shows a worse overall economic performance with the GDP growth of only 2.5 percent. A moderate exchange rate of appreciation ensures cheaper imports for import-intensive domestic producers and private consumers, which outweigh the benefit of protecting the economy from the Dutch Disease via restraining the exchange rate appreciation.

Finally, there was a consistent improvement in living standards for all population groups. Over 5 years, between 2001 and 2005, the poverty headcount index fell from 20 to 7 percent. It should be noted, however, that in rural areas poverty remains high. Inequality, on the other hand, as measured by the Gini coefficient, fell only slightly during the same period from 35.1 to 33.4, with the richest 10 percent (of population?) receiving about 27 percent of all income. Combining the results from the CGE simulations and micro household survey data it was estimated that the expansion of the oil sector contributed about 38 percent of the total annual poverty reduction. Results for inequality showed no significant change suggesting proportional increase in income for the rich and poor.

Chapter 6 concludes this study of Kazakhstan and its energy sector by developing an analytical framework correcting the national statistics for transfer pricing in the extracting industry. Trade margins in the oil and gas industry are disproportionably large in

Kazakhstan compared to other developed energy-exporting countries. This relates to a widely discussed issue of transfer pricing and also suggests that national statistical authorities do not correct the statistics for it. As a result, the oil and gas sector is undervalued and the services sector is artificially inflated. When the framework developed to adjust for the transfer pricing is utilised, the value added share of the oil and gas sector almost doubles, increasing from 8.5 percent to 16.1 percent in 2001. In 2005 the adjustment was less dramatic and represents an increase of 3.2 percentage points from 17.3 percent to 20.5 of the value added. These results indicate that, particularly in the earlier years, the size of the oil and gas sector and its contribution to the Kazakhstan's economic development was far greater than implied by the official numbers.

The corrections for transfer pricing introduced to the Input-Output tables and the value added structure may alter the results of economic models that rely on this data. The CGE modelling exercise in Chapter 5 would be particularly exposed to such risks given the construction of the SAM in Chapter 4. Comparing simulations with two different social accounting matrixes, the original and the one adjusted for transfer pricing Input-Output table, shows that the oil sector spillover is more profound when adjusted Input-Output tables are used. The larger absolute value of output of oil in the adjusted table entails smaller increase in oil output to support an 18 percent export rise compared to the unadjusted case. All other macro-variables however experienced a more significant positive boost in the adjusted case as compared to the case when official data were used. When transfer pricing is appropriately accounted for in the national statistics, an estimated contribution to the GDP growth of the oil industry can be as high as 5.2 percent annually out of 10 percent average annual growth over the studied period.

Finally, two research directions deserve further investigation, outside the scope of this thesis. Firstly, macroeconomic models such as CGE are well suited for the analysis of economic growth, exchange rates, relative prices and wages, however they do not capture micro-level effects such as the distribution of personal income, migration decisions or labour market participation decisions which can only be addressed effectively in a micro, household-level survey-based framework. This current study offers an assessment of the impact of the oil sector expansion on population using changes in consumption as the transmission mechanism for the oil shock. More complicated transmission mechanisms between micro and macro models would be needed in order to address the question in greater depth. This would therefore contribute to the growing body of literature on micro-macro simulation frameworks for *ex ante* analysis of the income distribution and poverty effects of macroeconomic trends.

Secondly, it was shown how transfer pricing in the oil and gas industry distorts the apparent structure of GDP and makes international comparison misleading. Transfer pricing is only one of the factors that might affect the domestic prices which serve as the basis for the compilation of national accounts. To account for various other distortions such as hidden subsidies and informal trade barriers one would be required to recalculate GDP at world prices. This exercise would give a more realistic picture of the economic structure and provide a stronger basis for any policy modelling and analysis.

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APPENDIXES

Appendix A – Chapter 1

A.1. Additional Statistics

Table A.1.1. Structure of the GDP by Sector

	2000	2001	2002	2003	2004	2005	2006	2007
Agriculture	8	9	8	8	7	6	5	6
Mining	13	11	12	12	14	16	16	15
Manufacturing	16	16	14	14	13	12	12	12
Electricity and water	3	3	3	3	2	2	2	2
Construction	5	5	6	6	6	8	10	9
Trade	12	12	12	12	12	12	11	12
Hotels and restaurants	1	1	1	1	1	1	1	1
Transport	10	10	10	11	10	10	9	9
Communication	1	1	2	2	2	2	2	3
Financial services	3	3	3	3	3	3	5	6
Real estate services	11	12	12	14	15	15	15	15
Public administration	2	2	2	2	2	2	2	2
Education	4	4	3	3	4	3	3	3
Health	2	2	2	2	2	2	2	2
Other services	2	2	2	2	2	2	2	2
Services provided by households	0.03	0.28	0.25	0.14	0.16	0.14	0.11	0.10
FISIM (-)	-1	-1	-1	-2	-2	-2	-3	-5
Value added	93	93	93	93	94	94	93	93
Taxes on products and imports	7	7	7	7	6	6	7	7
Subsidies on products and imports	0.07	0.13	0.05	0.08	0.08	0.09	0.09	0.10
GDP	100	100	100	100	100	100	100	100

Source: Agency of the Republic of Kazakhstan for Statistics

Table A.1.2. Indexes of Physical Volumes

Index of physical volume	2000	2001	2002	2003	2004	2005	2006	2007
Agriculture	96.8	117.1	103.2	102.2	99.9	107.1	106.0	108.9
Mining	121.0	114.4	116.3	110.3	112.9	102.4	107.5	102.7
Manufacturing	114.0	113.7	107.6	107.9	110.1	107.1	107.9	107.6
Electricity and water	105.8	108.6	102.9	110.3	102.3	105.2	102.7	109.2
Construction	114.0	127.4	119.5	109.8	114.4	139.5	136.4	116.9
Trade	105.0	113.5	108.6	110.2	110.5	109.3	109.8	112.8
Hotels and restaurants	110.3	113.8	122.6	124.2	117.8	119.6	110.1	116.4
Transport	118.0	108.6	108.7	107.8	109.5	107.0	107.0	107.7
Communication	124.3	115.7	118.0	125.8	130.0	135.9	130.4	134.5
Financial services	108.3	118.2	116.6	118.3	125.3	134.9	142.1	152.1
Real estate services	105.9	110.1	109.6	112.5	109.4	109.1	108.7	105.9
Public administration	105.8	101.2	111.9	113.5	106.7	105.7	104.6	103.8

Education	104.2	117.4	105.6	108.4	105.6	108.7	104.5	103.4
Health	100.0	107.6	105.5	105.3	106.3	101.8	103.6	102.7
Other services	105.8	116.7	111.6	109.0	105.8	102.4	108.3	112.6
Services provided by households	133.4	915.4	107.0	63.7	116.1	73.4	80.4	97.3
FISIM (-)	108.3	147.2	130.9	125.0	137.6	149.3	153.1	174.1
Value added	109.6	113.6	109.7	109.4	109.6	109.5	110.6	108.8
Taxes on products and imports	109.6	113.6	109.7	109.4	109.6	112.6	112.5	110.2
Subsidies on products and imports	26.3	203.4	45.0	168.6	116.3	111.2	110.9	110.9
GDP	109.8	113.5	109.8	109.3	109.6	109.7	110.7	108.9

Source: Agency of the Republic of Kazakhstan for Statistics

A.2. Inequality and Poverty Measures

Inequality

The Gini coefficient measures average income inequality with GE(*k*) being more sensitive to the top/bottom of the income distribution the more positive/negative *k* is.

Entropy difference based indicators of inequality are defined as follows:

GE(*k*) = $\frac{v_k \mu^{-k} - 1}{k(k-1)}$, where $v_k = \int y^k dF(y)$. *F(y)* is the income distribution function, and μ is the mean of *y*. This formulation is only defined when k ≠ 0 or 1. For these values, the entropy indicators are defined thus:

GE(0) = $\log \mu - \int \log y.dF(y)$ and GE(1) = $\frac{\mu}{\int y \log y.dF(y)} - \log \mu$.

Poverty

P(0) is the poverty headcount index or percentage of the poor in total population, P(1) represents poverty gap or how far on average the poor fall below the poverty line expressed as a percentage on the poverty line, and P(2) is the poverty severity. The Foster-Greer-Thorbecke measures of poverty can be written as follows (World Bank, 2005):

$P(\alpha) = \frac{1}{N} \sum_{i=1}^{N} \left(\frac{G_i}{z} \right)^{\alpha}$, where $G_i = \max(y_i - z, 0)$ is the poverty gap, z is the poverty line, N is the size of the sample and α is the parameter, the bigger the α the more weight is put on the position of the poores.

Appendix B – Chapter 2

B.1. Table of CGE Studies

Author	Model name (country)	Modeling emphasis	Base year	Model type (base year)	N of sectors; N of types of households	Parameters	Scenarious	Results	Additional Remarks
Peter Wehrheim (2003)	Russia (Russia)	Agriculture, Transition	(1990, updated to 1994)	Static; Extended version of 1-2-3	S =17:20; H = 1	Trade - synthetic (from the literature)	1. Increase in the Import prices; 2. Reduction in the capital stock of A; 3. TFP increase in A	**1.** GDP(-); Unemployment (+); Currency(-); Export(-). **2.** Price A(+); GDP(-); Unemp(+); Currency(+); Ex(-); Import(-). **3.** As in 2 but with the opposite sign	Small economy with the exception of export. Fixed nominal wage. Fixed capital stock, no capital mobility between sectors. Total amount of investments is fixed (the marginal prospensity to save adapts instead of investments to keep the savings-investments identity balanced). Low trade elasticities to concentrate on the short-run effects.
Zalai, E. (1998)	HUMUS (Hungary)	Transition	ng	Static	S = 22; H = ng	Trade - ng; LES-synthetic (fixed shares)	ng	ng	Small economy with the exception of export. Some elements of central planning (e.g. differentiation between eastern and western goods). Distinction between energy and nonenergy at the intermediate level. Endogenous wage setting

Kemfret, C., Welsch, H. (2000)	(Germany)	CO2 Abatement	2000?	Recursively dynamic	S = 13; H = ng	E-K-L - econometrically estimated	Environmental tax sufficient to achieve 1990's level of emissions	Results depend on the magnitude of elasticities and on the method of tax revenues distribution	Five-stage nested production function. Exogenous wages, unrestricted labour supply. Higher elasticities imply lower carbon tax rate for a given target CO2 reduction. More information in Welsch, H., and Hoster, F. (1995) A General Equilibrium Analysis of European Carbon/ Energy Taxation: Model Structure and Macroeconomic Results.
Kumbaro˘glu, G. S., (2003)	ENVEEM (Turkey)	Environmental taxation (SO2, NOx)	1991	Recursively dynamic. Neoclassical	S = 7; H = ng	ng	Environmental tax of various magnitudes on SO2 and Nox; Tax on fuel sulphur content	Emission taxes bring significant emissions reduction at a smaller GDP cost than sulphur content taxation. In the longer run sulphur taxation brings more emission reduction, however GDP loss is also higher	Nested energy-economy type production function. Exogenous labour growth and technological progress drives the dynamics in this model. No mention of values of elasticities used
Robinson et al (1999)	(Cameroon)	Oil boom, Dutch Disease	1979-80	Static. Extended version of 1-2-3	S = 6; H = 3	Calibrated from the SAM or taken from the literature	$500 million increase in foreign savings, which is directly channelled to investments	Domestic prices (+); Nominal wage (+); Real exchange rate (+); Employment (+); Import (+); Export (-); Agricultural output (-)	Small country, endogenous export price for some sectors. Fixed nominal, but floating real (ratio of tradables to non-tradables) exchange rate. Sector specific distortion parameter used to highlight the capital and labour return differential across sectors. Oil sector was not included in the production, but its effect is modelled as inflow of revenues

Ahammad, H., Klements, K. W., (1999)	WAM (Western Australia)	Economy-wide Impact of minerals industry growth	1989-90	Static	S = 42; H = ng	ng	Exogenous expansion of minerals industry by 7.1% and 9.9%	Results show that minerals contributed around 50% to overall WA GSP growth in the 1990s.	Single-region, specifically designed for WA model. Extended Input-output table used as the database. Five different combinations of assumptions about exchange rate and wages were used distinguishing between fixed, semi-fixed and flexible.
Kiuila, O., Peszko, G., (2006)	(Poland)	Adoption of the EU directive on SO2 and Nox emission limits in Poland	1995	Recursively dynamic	S = 17; H = 2	ng	1. An increase in average costs of electricity and heat production. 2. A transfer from the power sector to abatement technology and services providing sectors	1. Negative impact on most of the economic indicators, such as employment, output etc. 2. Much less negative impact	Capital is assumed to be growing at a constant rate of 0.04% per year and determines the economic growth. Labour supply is also exogenously growing at approx. 0.8% per year. The model projects to 2016 and only this year's results are considered
Borges, A., Goulder, L., (1984)	Extended version of the Fullerton-Shoven-Whaley model of tax analysis in the U.S. economy (USA)	Decomposition of the impact of higher energy prices	1973	Static, exogenous growth rates of major variables specified for every 4 year period (1973-2001)	S = 24; H = 6	From the literature	1. Base scenario: 8% annual oil price increase with supply fixed at 1973 level. GNP, labour supply, final demand (except demand for imported oil) grow at 2.76% per anuum. 2. Set of specific simulation to highlight the importance of: terms-of-trade, savings and direct effects of higher energy prices.	Out of the three effects the term-of-trade and savings effects had less negative impact on welfare (defined as the sum of national income and value of leisure at current wage rate) than the direct effect (reduction in factor productivity), which along, accounted for 50-84% of the total welfare loss. The savings effect was responsible for about 15% of the total loss. The magnitude of the terms-of-trade effect depended on the percentage of import in energy consumption, and accounted for about 35% of the total welfare reduction.	Extensions include the level of energy sector disaggregation and more comprehensive treatment of oil import. To exclude the dynamic effect of savings and investments, savings assumed no longer to be driven by return on capital, but represent fixed share of household income. Terms-of-trade effect was eliminated by assuming that the imported oil is purchased at the cost of domestic production, thus the difference between the market price and domestic production price accrues to the capital owner in the home country rather than foreign producers. The importance of the direct effect (changes in factor productivity) was highlighted by excluding both, savings-investments effect and terms of trade effect.

Johansen, L., (1964)	(Norway)	Multisectoral study of economic growth	1950	Static, exogenous growth rates applied for every period	S = 22; = 1	H	Estimated, derived, from the literature	Calculations include: 1. Effect of capital accumulation. 2. Increase in exogenous demand. 3. Change in technical progress. 4. Competitive imports' price increase	1. All prices decrease; increase in production, in particular textile, printing and dwellings. 2. Production in all sectors increases almost on the on-to-one basis, with lowers elasticities for agric. and dwel; prices decrease for high labour inputs sectors. 3. 1% increase causes prices to fall by apprx. 0.5-1%. 4. Results vary depending on the sector	Full employment of labour and capital and perfectly mobile across sectors. Production function is Cobb-Douglas. Exogenously determined imports and exports (using fixed production coefficients); in addition import is split into competitive and not competitive, which further split into imports of consumption and production goods. Solution (in terms of growth rates of endogenous variables) is obtained solving the system of 86 linear equations
Braber, Cohen, Revesz and Zolkiewski (1993)	Hungary, (Poland)	Policy impact under fixed and flexible price regimes	1987, 1990	Neoclassical, static	S = 5; = 10	H	Uniform, 0 or 1.	1. Government demand for services increases by 1% of total government expenditure in 1987(1990). 2. Same amount paid in transfers to poorest households, which is equivalent to 9.05%(5.47) rise.	1. Real output decreases by 0.63%(0.49) due to currency appreciation; Consumption increases by 0.72%(0.48) due to increase in income; Income inequality increases. 2. Similar results, notable increase of light and food industries.	Results reported only for the case of Poland. Zero substitution elasticity for import and 1 for export
IMF (2003)	Extended version of the DMR model (Kazakhstan)	Impact of the Higher oil price	2000	Static	S = 8; = 1	H	From the literature	10% increase in the oil price under: 1. Floating nominal exchange rate 2. Fixed nominal exchange rate	Under both scenarios balance of trade improves. 1. Moderate Dutch Disease effects: exchange rate appreciation; increase in the price of non-tradables; manufacturing suffers most. 2. Higher overall price increase and slower GDP growth than in 1; Real investments decline;	Small economy. Payments to foreign shareholders directly linked to the oil revenues and increases in taxes from the oil sector (except product taxes) fully invested abroad. Limited labour mobility, capital and wages are sector specific. The model's solution is found in percentage changes in variables using GEMPAC software.

Appendix C – Chapter 3

C.1. Description of the Variables

Nominal Variables

CPI -	Consumer price index
P_i -	Price of composite commodities
Pt_i -	Producer price
Pd_i -	Price of domestically produced output at the domestic market
Pk -	Price of capital (return)
Pl -	Price of labour (wage)
Pe_i -	Price of export at the domestic market
Pm_i -	Price of import at the domestic market
Pmw_i -	World price of imports (exogenous)
Pew_i -	World price of exports (exogenous)
B -	Household income spent on consumption
GB -	Government total budget
Y -	Household total income
R -	Exchange rate
S -	Total savings
Sh -	Household savings
GHtrf -	Transfers (total) from government to household

Real Variables

KS -	Total supply of capital
LS -	Total supply of labour

Unemp -	Unemployment level
C_i -	Household consumption demand
G_i -	Government consumption demand
I_i -	Investment demand
Xt_i -	Total domestic output
Xd_i -	Domestic output sold at the domestic market
X_i -	Output of composite commodity
E_i -	Export supply
M_i -	Import demand
Sg -	Government savings
Sf -	Foreign savings
HGtrf -	Transfers from household to government
HHtrf -	Inter-household transfers
HWtrf -	Transfers from household to the rest of the world
WHtrf -	Transfers from the rest of the world to household
GHtrfo -	Transfers from government to household other than unempl.
GWtrf -	Transfers from government to the rest of the world (e.g. debt)

Parameters

Values of the parameters are taken from Jensen and Tarr (2007). Labour supply elasticity ρ was set at -0.1 which is a standard value suggested by micro-estimates, for example Evers et al (2008). This implies that a 10 percent increase in real wage increases the labour supply by 1 percent. Frisch parameter φ was set at an average of what is found in the literature, for example De Melo and Tarr (1992).

Par.	**Value**	**Description**
μ_i -	cal.*	Household minimum consumption level in LES
αh_i -	cal.	Power parameter in the household S-G utility function
αg_i -	cal.	Power parameter in the government C-D utility function
αi_i -	cal.	Power parameter in the investment C-D utility function
mps -	cal.	Household marginal propensity to save
hub -	20%	Rate of unemployment benefits

ρ - -0.1 Parameter in the labour supply constraint equation

io_i - cal. Input-Output coefficients

γf_i - cal. Firm CES distribution parameter

γm_i - cal. Armington CES distribution parameter

γe_i - cal. CET distribution parameter

σf_i - 1.0 Firm CES elasticity of substitution (Capital-Labour)

σm_i - 3.0 Armington CES elasticity of substitution (Import-Domestic)

-3(construction)

σe_i - -1(oil) CET elasticity of substitution (Export-Domest.)

-2(other)

af_i - cal. Firm CES efficiency parameter

am_i - cal. Armington CES efficiency parameter

ae_i - cal. CET efficiency parameter

elasH - 1.0 Household's income elasticity of demand

φ - -1.1 Frisch parameter

w_{ij} - (Table C.1.1) Capital composition matrix

tc_i - cal. Tax rates on final consumption

tk - cal. Tax rate on capital

ty - cal. Tax rate on household income

tm_i - cal. Tariff rates on imports

te_i - cal. Export duty rates

tic_i - cal. Tax rates on intermediate consumption

**"Cal." denotes parameters that are calibrated from the SAM*

Auxiliary variables

U - Household's utility

TC - Total cost

TR - Total revenue

Pf_k - Price of k's production factor

F_k - Demand for k's production factor

Table C.1.1. Capital composition coefficients w_{ij}

	sec1	sec2	sec3	sec4	sec5	sec6
1. Agriculture	0	0	0	0	0	0
2. Forestry	0	0	0	0	0	0
3. Fishery	0	0	0	0	0	0
4. Mining of coal, lignite and peat	0	0	0	0.1112923	0.7053812	0.1112923
5. Crude oil extraction	0	0	0	0	0	0
6. Other mining	0	0	0	0	0	0
7. Food, close, tobacco	0	0	0	0	0	0
8. Fuels and chemicals	0	0	0	0	0	0
9. Metals and metal products	0.0098039	0.0098039	0.0098039	0.0101076	0.0039324	0.0101076
10. Other manufacturing	0.7045237	0.7045237	0.7045237	0.6079774	0.1510176	0.6079774
11. Electricity, gas and water	0	0	0	0	0	0
12. Construction	0.1019821	0.1019821	0.1019821	0.0814585	0.0908934	0.0814585
13. Trade	0.140585	0.140585	0.140585	0.1029779	0.0249051	0.1029779
14. Hotels and restaurants	0	0	0	0	0	0
15. Transport	0.0201939	0.0201939	0.0201939	0.0172807	0.0037254	0.0172807
16. Post and communication	0	0	0	0	0	0
17. Financial services	0	0	0	0	0	0
18. Public and other services	0.0229113	0.0229113	0.0229113	0.0689056	0.0201449	0.0689056

	sec7	sec8	sec9	sec10	sec11	sec12
1. Agriculture	0	0	0	0	0	0
2. Forestry	0	0	0	0	0	0
3. Fishery	0	0	0	0	0	0
4. Mining of coal, lignite and peat	0	0	0	0	0.0006937	0
5. Crude oil extraction	0	0	0	0	0	0
6. Other mining	0	0	0	0	0	0
7. Food, close, tobacco	0	0	0	0	0	0
8. Fuels and chemicals	0	0	0	0	0.036286	0
9. Metals and metal products	0.0268575	0.0263109	0.0129676	0.0088608	0.0070971	0.0086633
10. Other manufacturing	0.6118675	0.5550787	0.6608677	0.5970055	0.3860192	0.7846705
11. Electricity, gas and water	0	0	0	0	0	0
12. Construction	0.1496678	0.1642097	0.1111052	0.1449822	0.4733725	0.0278512
13. Trade	0.1016217	0.0959445	0.0870911	0.0855203	0.0463358	0.1149885
14. Hotels and restaurants	0	0	0	0	0	0
15. Transport	0.0106408	0.0064378	0.0094989	0.009135	0.0077552	0.0217452
16. Post and communication	0	0	0	0	0	0
17. Financial services	0	0	0	0	0	0
18. Public and other services	0.0993448	0.1520184	0.1184695	0.1544961	0.0424404	0.0420813

	sec13	sec14	sec15	sec16	sec17	sec18

1. Agriculture	0	0	0	0	0	0
2. Forestry	0	0	0	0	0	0
3. Fishery	0	0	0	0	0	0
4. Mining of coal, lignite and peat	0	0	0	0	0	0
5. Crude oil extraction	0	0	0	0	0	0
6. Other mining	0	0	0	0	0	0
7. Food, close, tobacco	0	0	0	0	0	0
8. Fuels and chemicals	0	0	0	0	0	0
9. Metals and metal products	0.0102256	0.0045969	0.0042957	0.0008184	0.0005552	0.0045969
10. Other manufacturing	0.4535181	0.4332683	0.7103336	0.5668718	0.1971138	0.4332683
11. Electricity, gas and water	0	0	0	0	0	0
12. Construction	0.39677	0.3464376	0.1428708	0.2027465	0.714149	0.3464376
13. Trade	0.0769559	0.09849	0.0772986	0.0760286	0.0482342	0.09849
14. Hotels and restaurants	0	0	0	0	0	0
15. Transport	0.0123965	0.0066109	0.0095487	0.0051975	0.0042489	0.0066109
16. Post and communication	0	0	0	0.0587991	0	0
17. Financial services	0	0	0	0	0.0127305	0
18. Public and other services	0.0501339	0.1105963	0.0556526	0.089538	0.0229683	0.1105963

C.2. Model Equations

Household

$$\mathrm{C_i} = \mu_\mathrm{i} + \frac{\alpha \mathrm{h_i}(B - \sum_{\mathrm{j=1}}^{\mathrm{n}}(1+\mathrm{tc_j}).P_\mathrm{j}\mu_\mathrm{j})}{(1+\mathrm{tc_i}).P_\mathrm{i}}$$

Household's consumption demand (LES) (C.1)

$$Y = Pk.\mathrm{KS} + Pl(\mathrm{LS} - \mathrm{Unemp}) + GHtrf$$

Household's gross income (C.2)

$$B = Y - \mathrm{ty}.Y - Sh - R.\mathrm{HWtrf} - CPI.\mathrm{HGtrf} - CPI.\mathrm{HHtrf}$$

Household's budget available for consumption (C.3)

$$Sh = \mathrm{mps}.(Y - \mathrm{ty}.Y - R.\mathrm{HWtrf} - CPI.\mathrm{HGtrf} - CPI.\mathrm{HHtrf})$$

Household's saving (C.4)

Government

$$GB = \sum_{i=1}^{n}\left(\mathrm{tc_i}.P_\mathrm{i}.\mathrm{C_i} + \mathrm{tk_i}.Pk.\mathrm{K_i} + \mathrm{tic_i}.\sum_{\mathrm{j=1}}^{\mathrm{n}}\mathrm{io_{ij}}.P_\mathrm{j}.\mathrm{Xt_i}\right) +$$
$$+\sum_{i=1}^{n}\left(\mathrm{tm_i}.R.Pmw_\mathrm{i}.\mathrm{M_i} + \mathrm{te_i}.R.Pe_\mathrm{i}.\mathrm{E_i}\right) + \mathrm{ty}.Y + CPI.\mathrm{HGtrf} + R.\mathrm{WGtrf}$$

Government's total budget (C.5)

$$GHtrf = \mathrm{hub}.Pl.\mathrm{Unemp}$$

Total transfers from Government to Household (C.6)

$$\mathrm{G_i} = \frac{\alpha\mathrm{g_i}(GB - GHtrf - CPI.\mathrm{Sg} - R.\mathrm{GWtrf})}{P_\mathrm{i}}$$

Government's consumption demand (C.7)

Firm

$$\mathrm{L_i} = \left(\frac{1-\gamma\mathrm{f_i}}{Pl}\right)^{\sigma\mathrm{f_i}}\left(\frac{\mathrm{Xt_i}}{\mathrm{af_i}}\right)\left(\gamma\mathrm{f_i}^{\sigma\mathrm{f_i}}[(1+\mathrm{tk_i})Pk]^{1\text{-}\sigma\mathrm{f_i}} + (1-\gamma\mathrm{f_i})^{\sigma\mathrm{f_i}}\,Pl^{1\text{-}\sigma\mathrm{f_i}}\right)^{\frac{\sigma\mathrm{f_i}}{1\text{-}\sigma\mathrm{f_i}}}$$

Firms' labour demand (C.8)

$$\mathrm{K_i} = \left(\frac{\gamma\mathrm{f_i}}{(1+\mathrm{tk_i})Pk}\right)^{\sigma\mathrm{f_i}}\left(\frac{\mathrm{Xt_i}}{\mathrm{af_i}}\right)\left(\gamma\mathrm{f_i}^{\sigma\mathrm{f_i}}((1+\mathrm{tk_i})Pk)^{1\text{-}\sigma\mathrm{f_i}} + (1-\gamma\mathrm{f_i})^{\sigma\mathrm{f_i}}.Pl^{1\text{-}\sigma\mathrm{f_i}}\right)^{\frac{\sigma\mathrm{f_i}}{1\text{-}\sigma\mathrm{f_i}}}$$

Firm's capital demand (C.9)

$$Pt_\mathrm{i}.\mathrm{Xt_i} = (1+\mathrm{tk_i})Pk.\mathrm{K_i} + Pl.\mathrm{L_i} + (1+\mathrm{tic_i})\sum_{\mathrm{j=1}}^{\mathrm{n}}\mathrm{io_{ji}}.P_\mathrm{j}.\mathrm{Xt_i}$$

Zero profit condition in Firm's maximization problem (C.10)

Investment

$$S = Sh + CPI.\mathrm{Sg} + R.\mathrm{Sf}$$

Total savings (C.11)

$$\mathrm{I_i} = \frac{\alpha \mathrm{i_i}.S}{P_{\mathrm{i}}}$$

Demand for investment commodities (C.12)

Foreign sector

$$Pm_{\mathrm{i}} = (1 + \mathrm{tm_i})R.Pmw_{\mathrm{i}}$$

Domestic price of imports (C.13)

$$Pe_{\mathrm{i}} = Pew_{\mathrm{i}}.R/(1 + \mathrm{te_i})$$

Domestic price of exports (C.14)

$$\mathrm{M_i} = \left(\frac{\gamma \mathrm{m_i}}{Pm_{\mathrm{i}}}\right)^{\sigma \mathrm{m_i}} \left(\frac{\mathrm{X_i}}{\mathrm{am_i}}\right) \left(\gamma \mathrm{m_i}^{\sigma \mathrm{m_i}}.Pm_{\mathrm{i}}^{1\text{-}\sigma \mathrm{m_i}} + (1 - \gamma \mathrm{m_i})^{\sigma \mathrm{m_i}} Pd_{\mathrm{i}}^{1\text{-}\sigma \mathrm{m_i}}\right)^{\frac{\sigma \mathrm{m_i}}{1\text{-}\sigma \mathrm{m_i}}}$$

Demand for imports (C.15)

$$\mathrm{Xd_i} = \left(\frac{1 - \gamma \mathrm{m_i}}{Pd_{\mathrm{i}}}\right)^{\sigma \mathrm{m_i}} \left(\frac{\mathrm{X_i}}{\mathrm{am_i}}\right) \left(\gamma \mathrm{m_i}^{\sigma \mathrm{m_i}}.Pm_{\mathrm{i}}^{1\text{-}\sigma \mathrm{m_i}} + (1 - \gamma \mathrm{m_i})^{\sigma \mathrm{m_i}} Pd_{\mathrm{i}}^{1\text{-}\sigma \mathrm{m_i}}\right)^{\frac{\sigma \mathrm{m_i}}{1\text{-}\sigma \mathrm{m_i}}}$$

Demand for domestically produced goods (C.16)

$$P_{\mathrm{i}}.\mathrm{X_i} = Pm_{\mathrm{i}}.\mathrm{M_i} + Pd_{\mathrm{i}}.\mathrm{Xd_i}$$

Zero profit condition in Armington’s substitution (C.17)

$$\mathrm{E_i} = \left(\frac{\gamma \mathrm{e_i}}{Pe_{\mathrm{i}}}\right)^{\sigma \mathrm{e_i}} \left(\frac{\mathrm{Xt_i}}{\mathrm{ae_i}}\right) \left(\gamma \mathrm{e_i}^{\sigma \mathrm{e_i}}.Pe_{\mathrm{i}}^{1\text{-}\sigma \mathrm{e_i}} + (1 - \gamma \mathrm{e_i})^{\sigma \mathrm{e_i}} Pd_{\mathrm{i}}^{1\text{-}\sigma \mathrm{e_i}}\right)^{\frac{\sigma \mathrm{e_i}}{1\text{-}\sigma \mathrm{e_i}}}$$

Supply of export (C.18)

$$\mathrm{Xd}_{\mathrm{i}} = \left(\frac{1-\gamma \mathrm{e}_{\mathrm{i}}}{Pd_{\mathrm{i}}}\right)^{\sigma \mathrm{e}_{\mathrm{i}}} \left(\frac{\mathrm{Xt}_{\mathrm{i}}}{\mathrm{ae}_{\mathrm{i}}}\right) \left(\gamma \mathrm{e}_{\mathrm{i}}^{\sigma \mathrm{e}_{\mathrm{i}}} . Pe_{\mathrm{i}}^{1-\sigma \mathrm{e}_{\mathrm{i}}} + (1-\gamma \mathrm{e}_{\mathrm{i}})^{\sigma \mathrm{e}_{\mathrm{i}}} Pd_{\mathrm{i}}^{1-\sigma \mathrm{e}_{\mathrm{i}}}\right)^{\frac{\sigma \mathrm{e}_{\mathrm{i}}}{1-\sigma \mathrm{e}_{\mathrm{i}}}}$$

Supply of domestically produced goods to the domestic market (C.19)

$$Pt_{\mathrm{i}} . \mathrm{Xt}_{\mathrm{i}} = Pe_{\mathrm{i}} . \mathrm{E}_{\mathrm{i}} + Pd_{\mathrm{i}} . \mathrm{Xd}_{\mathrm{i}}$$

Zero profit condition in Firm's transformation (CET) (C.20)

$$\sum_{\mathrm{i}=1}^{\mathrm{n}} Pmw_{\mathrm{i}} . \mathrm{M}_{\mathrm{i}} + \mathrm{HWtrf} = \sum_{\mathrm{i}=1}^{\mathrm{n}} Pew_{\mathrm{i}} . \mathrm{E}_{\mathrm{i}} + \mathrm{Sf}$$

Balance of payment (C.21)

Factors

$$\frac{u^{\mathrm{t}} - u^{0}}{u^{0}} = \rho \frac{\omega^{\mathrm{t}} - \omega^{0}}{\omega^{0}}, t = 0,1,\ u = \mathrm{Unemp/LS};\ \omega = PL / CPI$$

Labour supply constraint (C.22)

$$\mathrm{LS} = \sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{L}_{\mathrm{i}} + \mathrm{Unemp}$$

Labour market clearance (C.23)

$$\mathrm{KS} = \sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{K}_{\mathrm{i}}$$

Capital market clearance (C.24)

Market clearance and CPI

$$\mathrm{X}_{\mathrm{i}} = \sum_{\mathrm{j}=1}^{\mathrm{n}} \mathrm{io}_{\mathrm{ij}} . \mathrm{Xt}_{\mathrm{j}} + \mathrm{G}_{\mathrm{i}} + \mathrm{C}_{\mathrm{i}} + \mathrm{I}_{\mathrm{i}}$$

Market clearance for commodities (C.25)

$$CPI^{t} = \frac{\sum_{i=1}^{n}(1+tc_i^t)P_i^t.C_i^0}{\sum_{i=1}^{n}(1+tc_i^0)P_i^0.C_i^0}, t = 0,1$$

Consumer price index (C.26)

C.3. Linear Expenditure System (LES)

In the following derivations all notations and equations correspond to those described in the main text, with the exception that all calculations are done assuming taxes to be zero. This simplification by no means changes the nature of equations and in order to include tax on final consumption, one would simply need to replace P_i to $(1+tc_i)\ P_i$. Number of firms in the economy equal number of commodities equal n.

Given Stone-Geary representation of the household's utility function

$$U(C_1,...,C_n) = \prod_{i=1}^{n}(C_i - \mu_i)^{\alpha h_i} \tag{C.1}$$

Household solves the following problem

$$\max_{C_i} U(C_1,...,C_n) \qquad \text{subject to}$$

$$B = \sum_{i=1}^{n} P_i C_i \text{, where } C_i > \mu_i \geq 0, \sum_{i=1}^{n} \alpha h_i = 1 \tag{C.2}$$

The lagrangian for this optimization problem reads

$$L = \prod_{i=1}^{n}(C_i - \mu_i)^{\alpha h_i} + \lambda\left(B - \sum_{i=1}^{n} P_i C_i\right) \tag{C.3}$$

To simplify calculation let's assume that $C_i - \mu_i = Z_i$, then Lagrangian can be rewritten as

$$\mathrm{L} = \prod_{i=1}^{n} \mathrm{Z_i}^{\alpha \mathrm{h_i}} + \lambda\left(B - \sum_{i=1}^{n} P_{\mathrm{i}}\left(\mathrm{Z_i} + \mu_{\mathrm{i}}\right)\right) \tag{C.4}$$

Taking the first order conditions and making equal to zero results in

$$\frac{\partial \mathrm{L}}{\partial \mathrm{Z_i}} = \alpha \mathrm{h_i}.\mathrm{Z_i^{\alpha h_i - 1}}.\prod_{j \neq i} \mathrm{Z_j^{\alpha h_i}} - \lambda P_{\mathrm{i}} = 0 \tag{C.5}$$

$$\frac{\partial \mathrm{L}}{\partial \lambda} = B - \sum_{i=1}^{n} P_{\mathrm{i}}\left(\mathrm{Z_i} + \mu_{\mathrm{i}}\right) = 0 \tag{C.6}$$

Now, after substituting utility function (C.1) into f.o.c. (C.5) and rearranging we get

$$\frac{\partial \mathrm{L}}{\partial \mathrm{Z_i}} = \frac{\alpha \mathrm{h_i}.\mathrm{U}}{\mathrm{Z_i}} - \lambda P_{\mathrm{i}} = 0 \tag{C.7}$$

Proceed by dividing f.o.c. for some arbitrary $\mathrm{Z_i}$ (C.5) by the f.o.c. for an arbitrary $\mathrm{Z_j}$ (the later f.o.c. will look exactly the same as (C.5), but with index j instead of i), then we will have

$$\frac{\partial \mathrm{L}/\partial \mathrm{Z_i}}{\partial \mathrm{L}/\partial \mathrm{Z_j}} = \frac{P_{\mathrm{i}}}{P_{\mathrm{j}}} - \frac{\alpha \mathrm{h_i}.\mathrm{Z_j}}{\alpha \mathrm{h_j}.\mathrm{Z_i}} = 0, \text{ from which follows that } \mathrm{Z_i} = \frac{P_{\mathrm{j}}.\alpha \mathrm{h_i}}{P_{\mathrm{i}}.\alpha \mathrm{h_j}} \mathrm{Z_j} \tag{C.8}$$

Now substitute $\mathrm{Z_i}$ into (C.6)

$$B = \frac{\mathrm{Z_j}}{\alpha \mathrm{h_j}} P_{\mathrm{j}} \sum_{i=1}^{n} \alpha \mathrm{h_i} + \sum_{i=1}^{n} P_{\mathrm{i}}.\mu_{\mathrm{i}} \tag{C.9}$$

Taking into account that $\sum_{i=1}^{n} \alpha \mathrm{h_i} = 1$, and replacing back $\mathrm{Z_i}$ we finally get familiar Linear Expenditure System:

$$C_j = \mu_j + \frac{\alpha h_j (B - \sum_{i=1}^{n} P_i \mu_i)}{P_j} \tag{C.10}$$

Calibration

There are several ways to calibrate unknown parameters for households. The approach that follows is widely used in the CGE literature. In brief, assigning specific values to income elasticity of demand and to the so called Frisch parameter allows calibrating two other sets of parameters - μ_i and αh_i.

From (C.10) follows income elasticity of demand

$$elasH = \frac{dC_j}{dB}\frac{B}{C_j} = \alpha h_j \frac{B}{P_j C_j} \tag{C.11}$$

, where $\frac{B}{P_j C_j}$ is the inverted income share of good j. Assuming that *elasH* is given, αh_i can be readily obtained from (C.11) .

Frisch parameter φ can be used to derive μ_i. Frisch parameter defined as the expenditure elasticity of the marginal utility of expenditure or more formally

$$\varphi = \frac{\partial \lambda}{\partial B}\frac{B}{\lambda} = -\frac{B}{B - \sum_{i=1}^{n} P_i . \mu_i} \tag{C.12}$$

By substituting (C.12) into (C.10) and rearranging we have

$$\mu_i = C_i + \frac{1}{\varphi}\frac{\alpha h_i B}{P_i} \tag{C.13}$$

C.4. Constant Elasticity of Substitution Function (CET)

In the following derivations all notations and equations correspond to those described in the main text, with the exception that all calculations are done assuming taxes to be zero. This simplification by no means changes the nature of equations and in order to include tax on production factors, one would simply need to replace Pf_i to $(1+tf_i)\,Pf_i$. There are n firms in the economy and every firm produces only one commodity. To avoid notational clutter we drop the firm subscript i, thus for the representative firm, which faces CES production technology, demand for factors of production (F_k), where k=1:m, can be derived in the following way.

$$\min_{F_k} TC = \sum_{k=1}^{m} Pf_k F_k \tag{C.14}$$

Subject to

$$Xt = af\left(\sum_{k=1}^{m} \gamma f_k F_k^{-\rho}\right)^{-\frac{1}{\rho}} \tag{C.15}$$

, where TC is total cost of production, af is the efficiency parameter, F_k and Pf_k represent demand and price for k's production factor, γf_k is the share parameter and $\sum_{k=1}^{m} \gamma f_k = 1$, and $\rho = \frac{1-\sigma f}{\sigma f}$, where σf is the elasticity of substitution.

This optimization problem will have the following Lagrangian:

$$L = \sum_{k=1}^{m} Pf_k . F_k - \lambda\left(af\left(\sum_{k=1}^{m} \gamma f_k F_k^{-\rho}\right)^{-1/\rho} - Xt\right) \tag{C.16}$$

Taking the first order conditions and making it equal to zero we get:

$$\frac{\partial L}{\partial F_k} = Pf_k - \lambda . af . \gamma f_k . F_k^{-(1+\rho)}\left(\sum_{k=1}^{m} \gamma f_k F_k^{-\rho}\right)^{-\left(1+\frac{1}{\rho}\right)} = 0 \tag{C.17}$$

$$\frac{\partial \mathrm{L}}{\partial \lambda} = \mathrm{af}\left(\sum_{k=1}^{m} \gamma \mathrm{f_k} \mathrm{F_k}^{-\rho}\right)^{-\frac{1}{\rho}} - \mathrm{Xt} = 0 \tag{C.18}$$

I proceed by dividing f.o.c. for some arbitrary $\mathrm{F_k}$ (C.17) by the f.o.c. for an arbitrary $\mathrm{F_s}$ (the f.o.c. for $\mathrm{F_s}$ will look exactly the same as (C.17), but with index s instead of k).

$$\frac{\partial \mathrm{L} / \partial \mathrm{F_k}}{\partial \mathrm{L} / \partial \mathrm{F_s}} = -\frac{Pf_{\mathrm{k}}}{Pf_{\mathrm{s}}} + \frac{\gamma \mathrm{f_k}}{\gamma \mathrm{f_s}}\left(\frac{\mathrm{F_k}}{\mathrm{F_s}}\right)^{-(1+\rho)} = 0 \tag{C.19}$$

From what follows:

$$\mathrm{F_k} = \mathrm{F_s}\left(\frac{Pf_{\mathrm{k}}}{Pf_{\mathrm{s}}} . \frac{\gamma \mathrm{f_s}}{\gamma \mathrm{f_k}}\right)^{1/(-(1+\rho))} \tag{C.20}$$

Now substitute (C.20) into (C.15) to get

$$\mathrm{Xt} = \mathrm{af} . \mathrm{F_s}\left(\frac{\gamma \mathrm{f_s}}{Pf_{\mathrm{s}}}\right)^{\frac{1}{-(1+\rho)}}\left(\sum_{k=1}^{m} \gamma \mathrm{f_k}^{1/(1+\rho)} . Pf_{\mathrm{k}}^{\rho/(1+\rho)}\right)^{-\frac{1}{\rho}} \tag{C.21}$$

and after some rearrangements we have firm's demand for production factors:

$$\mathrm{F_s} = \left(\frac{\gamma \mathrm{f_s}}{Pf_{\mathrm{s}}}\right)^{\frac{1}{1+\rho}}\left(\frac{\mathrm{Xt}}{\mathrm{af}}\right)\left(\sum_{k=1}^{m} \gamma \mathrm{f_k}^{1/(1+\rho)} . Pf_{\mathrm{k}}^{\rho/(1+\rho)}\right)^{\frac{1}{\rho}} \tag{C.22}$$

Or alternatively, using elasticity of substitution σf (C.22) can be rewritten as:

$$\mathrm{F_s} = \left(\frac{\gamma \mathrm{f_s}}{Pf_{\mathrm{s}}}\right)^{\sigma\mathrm{f}}\left(\frac{\mathrm{Xt}}{\mathrm{af}}\right)\left(\sum_{k=1}^{m} \gamma \mathrm{f_k}^{\sigma\mathrm{f}} . Pf_{\mathrm{k}}^{1-\sigma\mathrm{f}}\right)^{\frac{\sigma\mathrm{f}}{1-\sigma\mathrm{f}}} \tag{C.23}$$

Calibration

Assuming substitution elasticities σf are given from outside of the model, then af and γf_k can be calculated. To find γf_k lets rearrange equation (C.19) and call the right hand side of the resulting equation (C.24) as Q_s. Lets do the same operation with remaining first order conditions. There will be m-1 of (C.24) type equations where f.o.c. for F_k divided by all remaining first order conditions.

$$\frac{\gamma f_k}{\gamma f_s} = \frac{Pf_k}{Pf_s}\left(\frac{F_k}{F_s}\right)^{1+\rho} \tag{C.24}$$

From $\sum_{k=1}^{m} \gamma f_k = 1$ we can find γf_s and substitute it into (C.24)

$$\frac{\gamma f_k}{1 - \sum_{k=1,k\neq s}^{m} \gamma f_k} = \frac{Pf_k}{Pf_s}\left(\frac{F_k}{F_s}\right)^{1+\rho} = Q_s \tag{C.25}$$

Now, using remaining m-1 (C.24) type equations we express gammas in the denominator of (C.25) in terms of γf_k and $Q_1,\ldots,Q_m$.

$$\frac{\gamma f_k}{1 - \gamma f_k\left(1 - \sum_{r=1,r\neq s}^{m} \frac{1}{Q_r}\right)} = Q_s \tag{C.26}$$

And after rearrangement we have

$$\gamma f_k = \frac{Q_s}{1 + Q_s\left(1 - \sum_{r=1,r\neq s}^{m} \frac{1}{Q_r}\right)} \tag{C.27}$$

For the case of two production factors (labour and capital) (C.27) reduces to:

$$\gamma f_{capital} = \frac{1}{1 + \frac{Pl}{Pk}\left(\frac{K}{L}\right)^{1+\rho}} \quad \text{and } \gamma f_{labour} = 1 - \gamma f_{capital}$$

Once we have σf and γf we can derive af using equation (C.15) and bearing in mind that $\rho = \frac{1-\sigma f}{\sigma f}$:

$$af = Xt\left(\sum_{k=1}^{m} \gamma f_k F_k^{-\rho}\right)^{\frac{1}{\rho}} \tag{C.28}$$

Appendix D – Chapter 4

D.1. Key to the Sector Names and Matching I-O with KHBS

SAM No	Classification according to I-O	English translation	KHBS aggregation
1	Продукция сельского хозяйства, охоты и связанные с этим услуги	Agriculture, Hunting and related services	Agriculture and related services
2	Продукция лесного хозяйства, лесозаготовок и связанные с этим услуги	Forestry, production of timber and related services	Agriculture and related services
3	Рыба и прочая продукция рыболовства; услуги, связанные с рыболовством и рыбоводством	Fishery and related services	Agriculture and related services
4	Каменный уголь и лигнит; торф	Coal, lignite and peat	Coal, other solid fuels
5	Сырая нефть и природный газ; услуги, связанные с добычей нефти и газа, кроме изыскательских работ	Crude oil and natural gas, services related to extraction except exploration services	Coal, other solid fuels
6	Металлические руды	Mining of metal ores	Coal, other solid fuels
7	Прочая продукция горнодобывающей промышленности и разработки карьеров	Other mining and quarrying	Coal, other solid fuels
8	Пищевые продукты и напитки	Food products and beverages	Food and Drinks, Tobaco
9	Табачные изделия	Tobacco products	Food and Drinks, Tobaco
10	Текстиль	Textile	Furniture, Textile, Home appliances, Cleaning, Home products
11	Одежда; меха	Garments and furs	Close and Shoes
12	Кожа и изделия из кожи	Leather and leather products	Furniture, Textile, Home appliances, Cleaning, Home products
13	Древесина и изделия из древесины и пробки (кроме мебели), изделия из соломки и материалов для плетения	Wood and wood products except furniture	Furniture, Textile, Home appliances, Cleaning, Home products
14	Целлюлоза, бумага и изделия из бумаги	Cellulose, paper and paper products	Furniture, Textile, Home appliances, Cleaning, Home products
15	Печатная продукция и носители информации	Printed matter and other information mediums	Books, newspapers, magazines
16	Кокс, продукты переработки нефти и другое топливо	Coke, petroleum products and other fuels	Gasoline and fuels
17	Химические вещества, химические продукты и химические волокна	Chemicals	Other personal usage goods
18	Резиновые и пластмассовые изделия	Rubber and plastic products	Other personal usage goods
19	Прочие неметаллические минеральные изделия	Other non-metal mineral products	Other personal usage goods
20	Основные металлы	Base metals	Other personal usage goods
21	Готовые металлические изделия, кроме машин и оборудования	Metal products, except machinery and equipment	Other personal usage goods
22	Машины и оборудование, не включенные в другие группировки	Machinery and equipment	Other personal usage goods
23	Оборудование офисное и техника вычислительная (компьютеры)	Office equipment and computers	Perosnal goods, tv, computers etc.
24	Электрическое оборудование и аппаратура, не включенные в другие группировки	Electrical equipment not included into other sectors	Perosnal goods, tv, computers etc.
25	Оборудование и аппаратура для радио, телевидения и связи	Radio, television and communication equipment	Perosnal goods, tv, computers etc.
26	Медицинские приборы и инструменты, точные и оптические приборы, наручные и прочие часы	Medical equipment	Perosnal goods, tv, computers etc.
27	Автомобили, прицепы и полуприцепы	Motor vehicles, trailers and semi-trailers	Cars and other transport equipment
28	Прочее транспортное оборудование	Other transportation equipment	Cars and other transport equipment
29	Мебель; прочие промышленные товары, не включенные в другие группировки	Furniture and other manufacturing	Furniture, Textile, Home appliances, Cleaning, Home products
30	Услуги по вторичной переработке сырья	Recycling services	Total services
31	Электроэнергия, газ, пар и горячая вода	Production of electricity, gas and water	Electricity, gas, heat and water, central heating
32	Собранная и очищенная вода, услуги по распределению воды	Treatment and distribution of water	Electricity, gas, heat and water, central heating
33	Строительные работы	Construction	Construction and housing repair

34	Услуги по техническому обслуживанию и ремонту автомобилей и мотоциклов и относящихся к ним деталей и принадлежностей	Maintenance and repair of motor vehicles, motorcycles	Car repair and maintenance services
35	Услуги по оптовой и комиссионной торговле, включая торговлю автомобилями и мотоциклами	Wholesale trade	Total services
36	Услуги по розничной торговле, кроме торговли автомобилями и мотоциклами; услуги по ремонту предметов личного пользования и бытовых товаров	Retail trade	Total services
37	Услуги гостиниц, кемпингов и прочих мест для кратковременного проживания	Hotels and other accommodation services	Hotels and Restaraunts
38	Услуги по обеспечению питанием и напитками	Food and beverage supply services	Hotels and Restaraunts
39	Услуги столовых и услуги по доставке готовой пищи	Canteens and food delivery	Hotels and Restaraunts
40	Транспорт - всего	Transport	Transport
41	Услуги почты и электросвязи	Post and communication	Post, Internet, Telecommunication
42	Услуги по финансовому посредничеству, кроме услуг по страхованию и пенсионному обеспечению	Financial intermediation services except insurance and pensions	Financial and legal services, including rent and insurance
43	Услуги по страхованию и пенсионному обеспечению, кроме услуг по обязательному социальному обеспечению	Insurance and pensions	Financial and legal services, including rent and insurance
44	Услуги, вспомогательные по отношению к финансовому посредничеству	Services ancillary to financial intermediation	Financial and legal services, including rent and insurance
45	Услуги, связанные с недвижимым имуществом	Real estate services	Financial and legal services, including rent and insurance
46	Услуги по аренде машин и оборудования без оператора и прокату предметов личного пользования и бытовых товаров	Vehicles and equipment lease services	Financial and legal services, including rent and insurance
47	Компьютерные услуги и связанные с ними услуги	Computer related services	Total services
48	Услуги в области исследований и разработок	R&D services	Total services
49	Услуги прочие, предоставляемые потребителям	Other services to consumers	Personal services
50	Услуги в области государственного управления и обороны, предоставляемые обществу в целом; услуги по обязательному социальному обеспечению	Public administration, defense and basic social maintenance	Total services
51	Услуги в области образования	Education services	Education
52	Услуги в области здравоохранения и социального обслуживания населения	Health services	Health and medical services
53	Услуги по канализации, удалению отходов, санитарной обработке и аналогичные услуги	Sewage and wastes disposal and	Public utilities - sewage, water disposal etc.
54	Услуги членских организаций, не включенных в другие группировки	Membership services not included elsewhere	Total services
55	Услуги по организации отдыха, культурных и спортивных мероприятий	Sport and leisure services	Amusement and recreational services
56	Прочие услуги	Other services	Other (pets, plants, related services)
57	Услуги домашних хозяйств	Services provided by households	Personal services

D.2. Disaggregated Household, Macro-SAM, 2002

	Production		Factors		Firms	Household – Total	Household by income deciles									
	Com	**Act**	**K**	**L**	**F**	**H**	**H1**	**H2**	**H3**	**H4**	**H5**	**H6**	**H7**	**H8**	**H9**	**H10**
Commodities		3925515				2205940	101429	126069	152323	161632	182247	204825	230382	266351	314903	465779
Activities	7542054															
Capital		1964842														
Labour		1429195														
Firms			1145140		50408	88889	267	239	404	865	1291	805	1555	2006	5190	76267
Household			780237	1418652	145882	40675										
H1			16493	17615	438		55	70	104	117	151	169	192	262	343	597
H2			26684	30719	393		81	102	151	170	220	246	280	381	499	869
H3			37446	52057	664		97	123	182	206	266	297	338	460	602	1049
H4			41688	55935	1419		85	108	159	180	233	260	296	402	527	918
H5			47757	81326	2119		97	123	181	205	265	296	336	457	599	1043
H6			74326	109938	1321		102	129	191	216	279	312	354	482	631	1100
H7			74936	147694	2553		107	136	200	227	293	327	372	506	663	1155
H8			103074	188108	3292		123	156	230	260	336	376	427	581	761	1327
H9			134330	261577	8518		143	181	267	302	391	436	496	675	884	1540
H10			223504	473682	125166		203	257	380	429	555	620	705	959	1256	2189
H_Urban			268963	1066092	132930											
H_Rural			511274	352560	12952											
Government			39465		57492	179793	4737	6985	9194	10908	13093	15545	18471	22396	28699	49764
Tax on cons.	78690															
Tax on exports	81049															
Tax on capital		110459														
Tax on interm.		112043														
Tax on imports																
Tax on income					182194	77474	2041	3010	3962	4700	5642	6699	7959	9651	12367	21444
Investments					719935	-39106	-62729	-63029	-58962	-59878	-51741	-23999	-15474	11770	59765	225172
Inventories																
Foreign sector	1747961			11137	184188	0										
Discrepancy																
Total	**9449754**	**7542054**	**1964842**	**1429789**	**1340099**	**2553666**	**46839**	**74659**	**108966**	**120538**	**153521**	**207214**	**246691**	**317338**	**427686**	**850213**

	Household by type of settlement		Governm.	Taxes						Investments		Foreign sec.	Discrepancy	
	H_Urban	**H_Rural**	**G**	**TC**	**TE**	**TK**	**TI**	**TM**	**TY**	**I**	**Inven**	**R**	**D**	**Total**
Commodities	1493439	712501	434999							907126	123334	1781690	71150	**9449754**
Activities														**7542054**
Capital														**1964842**
Labour												595		**1429789**
Firms	80997	7892	19226									36435		**1340099**
Household			102963									65257		**2553666**
H1			6928									3305		**46839**
H2			9054									4811		**74659**
H3			9368									5810		**108966**
H4			13249									5081		**120538**
H5			12942									5777		**153521**
H6			11745									6088		**207214**
H7			11128									6394		**246691**
H8			10942									7345		**317338**
H9			9420									8526		**427686**
H10			8187									12119		**850213**
H_Urban	19268	10888	63458									48380		**1609980**
H_Rural	6721	3798	39504									16876		**943686**
Government	124094	55699	48065	78690	81049	110459	112043	0	259668			0		**966724**
Tax on cons.														**78690**
Tax on exports														**81049**
Tax on capital														**110459**
Tax on interm.														**112043**
Tax on imports														**0**
Tax on income	53473	24001												**259668**
Investments	-168013	128908	313544									107236		**1101610**
Inventories										123334				**123334**
Foreign sector			47927											**1991213**
Discrepancy										71150				**71150**
Total	**1609980**	**943686**	**966724**	**78690**	**81049**	**110459**	**112043**	**0**	**259668**	**1101610**	**123334**	**1991213**	**71150**	

D.3. 2002 Kazakhstan Micro-SAM

		1	2	3	4	5	6	7	8	9	10
		com1	**com2**	**com3**	**com4**	**com5**	**com6**	**com7**	**com8**	**com9**	**com10**
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127	**H10**										
128	**G**										
129	**TC**	1981	74	0	108			8	45618	3061	133
130	**TE**	1055	101	7	90	36118	2992	95	327	14	162
131	**TK**										
132	**TI**										
133	**TM**										
134	**TY**										
135	**I**										
136	**R**	9693	451	54	922	60250	7162	3077	457471	5343	14214
137	**Total**	392260	5244	17256	104131	1152189	217470	30476	1043214	59965	68480

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129	**TC**	1919	90	64	79	323	1091	662	192	11	577
130	**TE**	404	111	56	43	48	10688	5404	73	2	19128
131	**TK**										
132	**TI**										
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134	**TY**										
135	**I**										
136	**R**	85870	17727	12587	41949	16422	41842	81464	37784	22790	69867
137	**Total**	176369	22472	27896	48599	42777	222427	125048	48327	57503	777036

		21	22	23	24	25	26	27	28	29	30
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94	**act37**										
95	**act38**										
96	**act39**										
97	**act40**										
98	**act41**										
99	**act42**										
100	**act43**										
101	**act44**										
102	**act45**										
103	**act46**										
104	**act47**										
105	**act48**										
106	**act49**										
107	**act50**										
108	**act51**										

109	**act52**										
110	**act53**										
111	**act54**										
112	**act55**										
113	**act56**										
114	**act57**										
115	**K**										
116	**L**										
117	**F**										
118	**H1**										
119	**H2**										
120	**H3**										
121	**H4**										
122	**H5**										
123	**H6**										
124	**H7**										
125	**H8**										
126	**H9**										
127	**H10**										
128	**G**										
129	**TC**	149	963	16	1251	368	41	6971	104	10	
130	**TE**	63	878	1	999		222	16		2	
131	**TK**										
132	**TI**										
133	**TM**										
134	**TY**										
135	**I**										
136	**R**	49039	134632	12573	149621		23206	6868		42872	
137	**Total**	71820	161372	13402	160595	8785	26951	17401	34073	53679	13507

		31	32	33	34	35	36	37	38	39	40
		com31	**com32**	**com33**	**com34**	**com35**	**com36**	**com37**	**com38**	**com39**	**com40**
1	**com1**										
2	**com2**										
3	**com3**										
4	**com4**										
5	**com5**										
6	**com6**										
7	**com7**										
8	**com8**										
9	**com9**										
10	**com10**										
11	**com11**										
12	**com12**										
13	**com13**										
14	**com14**										
15	**com15**										

16	**com16**										
17	**com17**										
18	**com18**										
19	**com19**										
20	**com20**										
21	**com21**										
22	**com22**										
23	**com23**										
24	**com24**										
25	**com25**										
26	**com26**										
27	**com27**										
28	**com28**										
29	**com29**										
30	**com30**										
31	**com31**										
32	**com32**										
33	**com33**										
34	**com34**										
35	**com35**										
36	**com36**										
37	**com37**										
38	**com38**										
39	**com39**										
40	**com40**										
41	**com41**										
42	**com42**										
43	**com43**										
44	**com44**										
45	**com45**										
46	**com46**										
47	**com47**										
48	**com48**										
49	**com49**										
50	**com50**										
51	**com51**										
52	**com52**										
53	**com53**										
54	**com54**										
55	**com55**										
56	**com56**										
57	**com57**										
58	**act1**										
59	**act2**										
60	**act3**										
61	**act4**										
62	**act5**										
63	**act6**										
64	**act7**										
65	**act8**										

66	**act9**										
67	**act10**										
68	**act11**										
69	**act12**										
70	**act13**										
71	**act14**										
72	**act15**										
73	**act16**										
74	**act17**										
75	**act18**										
76	**act19**										
77	**act20**										
78	**act21**										
79	**act22**										
80	**act23**										
81	**act24**										
82	**act25**										
83	**act26**										
84	**act27**										
85	**act28**										
86	**act29**										
87	**act30**										
88	**act31**	315513									
89	**act32**		33927								
90	**act33**			483703							
91	**act34**				51700						
92	**act35**					511657					
93	**act36**						256187				
94	**act37**							29713			
95	**act38**								18809		
96	**act39**									20319	
97	**act40**										674075
98	**act41**										
99	**act42**										
100	**act43**										
101	**act44**										
102	**act45**										
103	**act46**										
104	**act47**										
105	**act48**										
106	**act49**										
107	**act50**										
108	**act51**										
109	**act52**										
110	**act53**										
111	**act54**										
112	**act55**										
113	**act56**										
114	**act57**										
115	**K**										

116	**L**										
117	**F**										
118	**H1**										
119	**H2**										
120	**H3**										
121	**H4**										
122	**H5**										
123	**H6**										
124	**H7**										
125	**H8**										
126	**H9**										
127	**H10**										
128	**G**										
129	**TC**	623	16	9551	55		832	198	22	4	831
130	**TE**	17		7	19						1502
131	**TK**										
132	**TI**										
133	**TM**										
134	**TY**										
135	**I**										
136	**R**	5060		122608		138					75019
137	**Total**	321214	33943	615870	51773	511795	257020	29910	18831	20323	751428

		41	42	43	44	45	46	47	48	49	50
		com41	**com42**	**com43**	**com44**	**com45**	**com46**	**com47**	**com48**	**com49**	**com50**
1	**com1**										
2	**com2**										
3	**com3**										
4	**com4**										
5	**com5**										
6	**com6**										
7	**com7**										
8	**com8**										
9	**com9**										
10	**com10**										
11	**com11**										
12	**com12**										
13	**com13**										
14	**com14**										
15	**com15**										
16	**com16**										
17	**com17**										
18	**com18**										
19	**com19**										
20	**com20**										

21	**com21**										
22	**com22**										
23	**com23**										
24	**com24**										
25	**com25**										
26	**com26**										
27	**com27**										
28	**com28**										
29	**com29**										
30	**com30**										
31	**com31**										
32	**com32**										
33	**com33**										
34	**com34**										
35	**com35**										
36	**com36**										
37	**com37**										
38	**com38**										
39	**com39**										
40	**com40**										
41	**com41**										
42	**com42**										
43	**com43**										
44	**com44**										
45	**com45**										
46	**com46**										
47	**com47**										
48	**com48**										
49	**com49**										
50	**com50**										
51	**com51**										
52	**com52**										
53	**com53**										
54	**com54**										
55	**com55**										
56	**com56**										
57	**com57**										
58	**act1**										
59	**act2**										
60	**act3**										
61	**act4**										
62	**act5**										
63	**act6**										
64	**act7**										
65	**act8**										
66	**act9**										
67	**act10**										
68	**act11**										
69	**act12**										
70	**act13**										

71	**act14**										
72	**act15**										
73	**act16**										
74	**act17**										
75	**act18**										
76	**act19**										
77	**act20**										
78	**act21**										
79	**act22**										
80	**act23**										
81	**act24**										
82	**act25**										
83	**act26**										
84	**act27**										
85	**act28**										
86	**act29**										
87	**act30**										
88	**act31**										
89	**act32**										
90	**act33**										
91	**act34**										
92	**act35**										
93	**act36**										
94	**act37**										
95	**act38**										
96	**act39**										
97	**act40**										
98	**act41**	108476									
99	**act42**		51807								
100	**act43**			5852							
101	**act44**				66830						
102	**act45**					349573					
103	**act46**						11474				
104	**act47**							22028			
105	**act48**								30071		
106	**act49**									230204	
107	**act50**										182413
108	**act51**										
109	**act52**										
110	**act53**										
111	**act54**										
112	**act55**										
113	**act56**										
114	**act57**										
115	**K**										
116	**L**										
117	**F**										
118	**H1**										
119	**H2**										
120	**H3**										

121	**H4**										
122	**H5**										
123	**H6**										
124	**H7**										
125	**H8**										
126	**H9**										
127	**H10**										
128	**G**										
129	**TC**	194	7	1	0	140		0		13	
130	**TE**	106	7	0			2	0		80	208
131	**TK**										
132	**TI**										
133	**TM**										
134	**TY**										
135	**I**										
136	**R**	8375	14937	9637			4542	2216		94376	4972
137	**Total**	117151	66758	15490	66830	349712	16018	24244	30071	324673	187593

		51	52	53	54	55	56	57	58	59	60
		com51	**com52**	**com53**	**com54**	**com55**	**com56**	**com57**	**act1**	**act2**	**act3**
1	**com1**								89942	14	110
2	**com2**								1603	716	0
3	**com3**								138		4984
4	**com4**								3275	7	0
5	**com5**								557		
6	**com6**										
7	**com7**								101	1	20
8	**com8**								1718	0	4
9	**com9**								56	0	
10	**com10**								1734	0	141
11	**com11**								60	18	4
12	**com12**								5	0	
13	**com13**								635	16	14
14	**com14**								332	2	8
15	**com15**								72	12	3
16	**com16**								9691	80	189
17	**com17**								10679	2	17
18	**com18**								763	3	6
19	**com19**								478	0	16
20	**com20**								496	5	362
21	**com21**								1085	7	19
22	**com22**								3286	5	1
23	**com23**								72	0	1
24	**com24**								15046	12	156
25	**com25**										0
26	**com26**								7	0	2
27	**com27**								305	3	34
28	**com28**								16		72

29	**com29**								7	0	0
30	**com30**										
31	**com31**								6637	26	34
32	**com32**								1123	0	2
33	**com33**								1611		
34	**com34**								546	1	
35	**com35**								7014	53	181
36	**com36**								836	10	8
37	**com37**										
38	**com38**								1		
39	**com39**								0		
40	**com40**								7508	1	879
41	**com41**								366	11	4
42	**com42**								4550	1	0
43	**com43**								1148	64	30
44	**com44**								152	8	4
45	**com45**								1712	102	16
46	**com46**								1118	2	
47	**com47**								128	6	3
48	**com48**								1032	42	20
49	**com49**								3939	63	9
50	**com50**								334	503	237
51	**com51**										
52	**com52**								3367	157	74
53	**com53**								727	2	1
54	**com54**										
55	**com55**								0	0	0
56	**com56**								88	3	16
57	**com57**										
58	**act1**										
59	**act2**										
60	**act3**										
61	**act4**										
62	**act5**										
63	**act6**										
64	**act7**										
65	**act8**										
66	**act9**										
67	**act10**										
68	**act11**										
69	**act12**										
70	**act13**										
71	**act14**										
72	**act15**										
73	**act16**										
74	**act17**										
75	**act18**										
76	**act19**										
77	**act20**										
78	**act21**										

79	**act22**										
80	**act23**										
81	**act24**										
82	**act25**										
83	**act26**										
84	**act27**										
85	**act28**										
86	**act29**										
87	**act30**										
88	**act31**										
89	**act32**										
90	**act33**										
91	**act34**										
92	**act35**										
93	**act36**										
94	**act37**										
95	**act38**										
96	**act39**										
97	**act40**										
98	**act41**										
99	**act42**										
100	**act43**										
101	**act44**										
102	**act45**										
103	**act46**										
104	**act47**										
105	**act48**										
106	**act49**										
107	**act50**										
108	**act51**	182277									
109	**act52**		128943								
110	**act53**			53467							
111	**act54**				22211						
112	**act55**					30473					
113	**act56**						17025				
114	**act57**							3319			
115	**K**								150263	2185	8780
116	**L**								39044	409	558
117	**F**										
118	**H1**										
119	**H2**										
120	**H3**										
121	**H4**										
122	**H5**										
123	**H6**										
124	**H7**										
125	**H8**										
126	**H9**										
127	**H10**										
128	**G**										

129	**TC**	94	93	96		23	31				
130	**TE**					0					
131	**TK**								942	66	98
132	**TI**								3184	0	77
133	**TM**										
134	**TY**										
135	**I**										
136	**R**					330					
137	**Total**	182371	129037	53563	22211	30826	17057	3319	379531	4619	17194

		61	62	63	64	65	66	67	68	69	70
		act4	**act5**	**act6**	**act7**	**act8**	**act9**	**act10**	**act11**	**act12**	**act13**
1	**com1**	2	7	17	17	85405	3047	4464	47	5	3
2	**com2**	15		58	5	11		9	71		1313
3	**com3**					8614					
4	**com4**	7065	209	451	88	6247		73	3461		168
5	**com5**	1064	105887	923	544	3926		109			18
6	**com6**			36376	0	0					1
7	**com7**	138	84	158	1468	232	2	5	1	22	52
8	**com8**	185	156	852	46	12824	51	694	2496	344	13
9	**com9**			0		5	2544				
10	**com10**	22	40	85	130	2203	233	15054	14117	103	6
11	**com11**	71	58	137	87	67	249	50	21583	121	9
12	**com12**	5	174	85	7	6	12	212	33	1649	1
13	**com13**	1753	181	475	117	434	8	11	816		1122
14	**com14**	4	60	60	245	16848	5852	26	176	16	1
15	**com15**	0	8	2	0	2329	207	2			
16	**com16**	527	288	167	443	2764	100	2398	659	22	925
17	**com17**	851	252	2722	833	1483	540	487	228	395	40
18	**com18**	564	263	1120	168	17539	837	671	202	33	10
19	**com19**	615	709	1265	414	7775	40	57	20		18
20	**com20**	3648	3693	4349	1384	1896	22	1016	40		141
21	**com21**	2166	1418	1217	92	3301	610	70	138	22	75
22	**com22**	275	511	1501	10	360	169	111	14	0	18
23	**com23**	5	3	12	1	37	7	1	0		0
24	**com24**	1832	946	642	53	1527	194	150	13		32
25	**com25**	57	0		1	2	0	14			0
26	**com26**	9	92	50		11	4	11			0
27	**com27**	58		78	15	151	2	13	1		8
28	**com28**	0			0	265					
29	**com29**	1	11	3		17	1	6	25	1	0
30	**com30**	100			98						
31	**com31**	4697	4347	2948	759	18185	401	1364	3399	306	551
32	**com32**		536	154	226	1161	33	19	237	19	6
33	**com33**		57803	201		1122		117			

34	**com34**	31	1385	8001	171	2434		2	20		231
35	**com35**	627	2257	10883	1557	35020	856	2248	4570	17	1853
36	**com36**	94	43	288	174	2546	110	189	14	0	45
37	**com37**		630			0					
38	**com38**		14	0		272		0			
39	**com39**		1001	4		0	0				1
40	**com40**	24310	78904	50790	2790	89239	7861	1510	2488	0	2449
41	**com41**		2029	175	10	1051	106	14	253	17	9
42	**com42**		7969	2918	3	2024	158	1	147		
43	**com43**		292								
44	**com44**	8123	18472	4581		2670			27		
45	**com45**		189824		26	3652	593	4	752		
46	**com46**		408	324	0	394		0			
47	**com47**		1870			189			7		0
48	**com48**		7708	231		136		5			
49	**com49**		37407	10604	4	4962	8400	24	386		2
50	**com50**										
51	**com51**		22054		4021	499					
52	**com52**		38872	238		77	25				
53	**com53**		3037	149		3087	567	9	311		2
54	**com54**		64			84			24		
55	**com55**					0			0		
56	**com56**								268		
57	**com57**										
58	**act1**										
59	**act2**										
60	**act3**										
61	**act4**										
62	**act5**										
63	**act6**										
64	**act7**										
65	**act8**										
66	**act9**										
67	**act10**										
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77	**act20**										
78	**act21**										
79	**act22**										
80	**act23**										
81	**act24**										
82	**act25**										
83	**act26**										

84	**act27**										
85	**act28**										
86	**act29**										
87	**act30**										
88	**act31**										
89	**act32**										
90	**act33**										
91	**act34**										
92	**act35**										
93	**act36**										
94	**act37**										
95	**act38**										
96	**act39**										
97	**act40**										
98	**act41**										
99	**act42**										
100	**act43**										
101	**act44**										
102	**act45**										
103	**act46**										
104	**act47**										
105	**act48**										
106	**act49**										
107	**act50**										
108	**act51**										
109	**act52**										
110	**act53**										
111	**act54**										
112	**act55**										
113	**act56**										
114	**act57**										
115	**K**	7803	329507	20906	1523	123231	11733	7418	9140	857	2613
116	**L**	32145	65679	33163	7133	59319	3312	10100	19884	577	3414
117	**F**										
118	**H1**										
119	**H2**										
120	**H3**										
121	**H4**										
122	**H5**										
123	**H6**										
124	**H7**										
125	**H8**										
126	**H9**										
127	**H10**										
128	**G**										
129	**TC**										
130	**TE**										
131	**TK**	2917	60942	3740	443	2045	596	523	1976	11	31
132	**TI**	1230	7718	4211	2189	10119	2063	4711	132	6	8
133	**TM**										

134	**TY**										
135	**I**										
136	**R**										
137	**Total**	103010	1055821	207316	27296	539798	51547	53970	88176	4544	15190

		71	72	73	74	75	76	77	78	79	80
		act14	**act15**	**act16**	**act17**	**act18**	**act19**	**act20**	**act21**	**act22**	**act23**
1	**com1**	8	0	69	26		9	18		11	
2	**com2**						0	11		4	
3	**com3**										
4	**com4**		5	1019	66	12	268	11136		202	
5	**com5**		505	36270	1498	159	3	14132		25	
6	**com6**				217		12	173622			
7	**com7**		0	2	198	0	5130	263		0	
8	**com8**	44	1	83	875	16	61	43		69	
9	**com9**	1			11		8				
10	**com10**	7	91	1	7	255	8	4		5	
11	**com11**	0	1	5	8	0	31	120	1	6	
12	**com12**				3		4	0		3	
13	**com13**	300	0	323	25		131	1023		39	13
14	**com14**	2411	1405	2	145	1	14	0	0	221	1
15	**com15**	7	1918	1	1	1	0	5	0	1	3
16	**com16**	36	939	6933	1588	272	1476	4012	57	931	
17	**com17**	222	346	3435	3203	2368	293	915	0	408	0
18	**com18**	79	167	15	53	1226	91	14	3	7	
19	**com19**	4	8	2	186	131	2018	55	0	37	
20	**com20**	1	5100	11	762	104	1492	50682	4277	265	40
21	**com21**	1	12	4199	265	263	77	688	108	185	49
22	**com22**	6		2896	22	0	19	183	340	2014	
23	**com23**		3	0	1		1	4	0	0	44
24	**com24**	5	15	74	44	8	159	5717	3	223	4
25	**com25**		1	1	0		1	0	0	4	
26	**com26**	9	0	0	0		3	7	1	91	24
27	**com27**		6	1	1	0	23	1	17	7	
28	**com28**						1	1			
29	**com29**		0	4	16		0	5	15	10	
30	**com30**		6				0	8888	2	1	
31	**com31**	139	820	11267	2451	235	2013	45811	94	1245	16
32	**com32**	1	9	550	30	12	430		2	44	0
33	**com33**			1872	100						
34	**com34**		79	1783	1186		70	2	48	25	
35	**com35**	30	873	31663	2242	37	2107	11420	31	5421	9
36	**com36**	6	463	1339	7	21	77	0	0	79	0
37	**com37**				0						
38	**com38**										
39	**com39**				0		0	0	0	0	
40	**com40**	449	59	8909	1293	256	2528	39124	482	3081	201

41	**com41**	3	169	17	11	26	11			22	
42	**com42**	1	7		2	26				19	
43	**com43**										
44	**com44**		24			0		6225			
45	**com45**		275		8	27	47			80	
46	**com46**					3	10			0	
47	**com47**		92	0	2	2	8			103	179
48	**com48**				40	772					
49	**com49**	5	912	87	30	1	90			44	129
50	**com50**							2714			
51	**com51**				37						
52	**com52**				4			811		1	
53	**com53**		1	1306	9	3	115	2915		110	0
54	**com54**										
55	**com55**							0			
56	**com56**									54	
57	**com57**										
58	**act1**										
59	**act2**										
60	**act3**										
61	**act4**										
62	**act5**										
63	**act6**										
64	**act7**										
65	**act8**										
66	**act9**										
67	**act10**										
68	**act11**										
69	**act12**										
70	**act13**										
71	**act14**										
72	**act15**										
73	**act16**										
74	**act17**										
75	**act18**										
76	**act19**										
77	**act20**										
78	**act21**										
79	**act22**										
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83	**act26**										
84	**act27**										
85	**act28**										
86	**act29**										
87	**act30**										
88	**act31**										
89	**act32**										
90	**act33**										

91	**act34**										
92	**act35**										
93	**act36**										
94	**act37**										
95	**act38**										
96	**act39**										
97	**act40**										
98	**act41**										
99	**act42**										
100	**act43**										
101	**act44**										
102	**act45**										
103	**act46**										
104	**act47**										
105	**act48**										
106	**act49**										
107	**act50**										
108	**act51**										
109	**act52**										
110	**act53**										
111	**act54**										
112	**act55**										
113	**act56**										
114	**act57**										
115	**K**	1351	4090	34273	14596	1857	7269	140456	13873	263	73
116	**L**	1212	7172	10308	4373	2134	6369	152018	3138	9232	25
117	**F**										
118	**H1**										
119	**H2**										
120	**H3**										
121	**H4**										
122	**H5**										
123	**H6**										
124	**H7**										
125	**H8**										
126	**H9**										
127	**H10**										
128	**G**										
129	**TC**										
130	**TE**										
131	**TK**	5	65	557	159	34	274	6794	56	229	1
132	**TI**	185	347	9530	1719	15	1950	7625	18	78	1
133	**TM**										
134	**TY**										
135	**I**										
136	**R**										
137	**Total**	6527	25985	168805	37518	10277	34701	687463	22568	24899	812

		81	82	83	84	85	86	87	88	89	90
		act24	**act25**	**act26**	**act27**	**act28**	**act29**	**act30**	**act31**	**act32**	**act33**
1	**com1**	0				8	120	0	2		459
2	**com2**	0				4	1		1		10
3	**com3**								0		
4	**com4**	1		1	7	99	46	0	3213		86
5	**com5**					76	43	53	34495		1718
6	**com6**										
7	**com7**	1			0	5			24	13	4246
8	**com8**	1			0	4	132	1	218	9	17
9	**com9**										
10	**com10**	44		6	1	63	194		10	1	8
11	**com11**	1	0	0		29	10	1	35	26	27
12	**com12**			0	0	0	0		1	11	
13	**com13**	1		9	1	389	68	0	31	1	12054
14	**com14**	8	1	6	0	14	13	1	11	1	97
15	**com15**	5	1	36		4			246	1	3
16	**com16**	17	1	12	2	3988	10	39	663	200	15038
17	**com17**	8	3	14	0	334	17	146	106	7	8539
18	**com18**	8	38	10	2	131	18	58	500	107	811
19	**com19**	1	0	17	0	166	14	5	147	76	33637
20	**com20**	203	523	216	127	1055	14	3021	373	628	21845
21	**com21**	103	0	21	14	528	16	5	284	43	39405
22	**com22**	1	0	4	9	45	4	7	60	31	29024
23	**com23**			1	0	1	0		5	0	4
24	**com24**	3708	4891	47	145	3133	13	1	7873	13	24591
25	**com25**	0	732	110		139			1	0	
26	**com26**	41	19	1238	7	16			116	7	1106
27	**com27**	0	0	0	196	7	3	0	9	10	1888
28	**com28**					5278			0		
29	**com29**	0	0		0	4	28		6	0	0
30	**com30**							3807	1		419
31	**com31**	125	42	233	86	1999	300	57	4823	1251	4650
32	**com32**	1	0	13	0	22	7	0	886	7281	147
33	**com33**								39134		4005
34	**com34**	0				118	105	24	929	32	457
35	**com35**	99	7	25	13	831	1299	201	27524	381	7557
36	**com36**	0	0	2	1	1287	37	108	924		117
37	**com37**		0						43		827
38	**com38**								9		0
39	**com39**								1	1	127
40	**com40**	727	257	51	34	1321	679	1986	7093	208	32673
41	**com41**	54	1	9	1	108	5	12	114	13	34
42	**com42**	1				49	4	43	128		21
43	**com43**										
44	**com44**							9		1	
45	**com45**	1				102	59	33	942	98	8078
46	**com46**					5		1	17	0	1207

47	**com47**					5		1	49	59	
48	**com48**								7	1	
49	**com49**	17	0	39	4	398	499	7	1091	220	69
50	**com50**										
51	**com51**						2916	0	7148	2	
52	**com52**								29	20	
53	**com53**	1	0	14	6	235	2		214	1912	608
54	**com54**			11				253		8	
55	**com55**										
56	**com56**	3		3	1	30		2	183	29	
57	**com57**										
58	**act1**										
59	**act2**										
60	**act3**										
61	**act4**										
62	**act5**										
63	**act6**										
64	**act7**										
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93	**act36**										
94	**act37**										
95	**act38**										
96	**act39**										

97	**act40**										
98	**act41**										
99	**act42**										
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101	**act44**										
102	**act45**										
103	**act46**										
104	**act47**										
105	**act48**										
106	**act49**										
107	**act50**										
108	**act51**										
109	**act52**										
110	**act53**										
111	**act54**										
112	**act55**										
113	**act56**										
114	**act57**										
115	**K**	1280	1268	663	2769	2651	1991	100	53999	4385	115800
116	**L**	2193	594	655	114	9095	1968	3488	103420	14363	104533
117	**F**										
118	**H1**										
119	**H2**										
120	**H3**										
121	**H4**										
122	**H5**										
123	**H6**										
124	**H7**										
125	**H8**										
126	**H9**										
127	**H10**										
128	**G**										
129	**TC**										
130	**TE**										
131	**TK**	68	38	14	2	194	57	37	7329	945	1228
132	**TI**	1	1	3	4	2	103	0	11043	1529	6533
133	**TM**										
134	**TY**										
135	**I**										
136	**R**										
137	**Total**	8724	8417	3483	3546	33969	10795	13507	315513	33927	483703

		91	92	93	94	95	96	97	98	99	100
		act34	**act35**	**act36**	**act37**	**act38**	**act39**	**act40**	**act41**	**act42**	**act43**
1	**com1**	8	3358	1828	189	167	783	3306		49	
2	**com2**	0	332	4		0	0	12		0	
3	**com3**		139	848	313	89	377	38			

4	**com4**	1	1280	2147	164	1	1	341	242		
5	**com5**	463	21209	189	15	0	0	37403			
6	**com6**	0						1			
7	**com7**	2	478	2487	3	3	1	273			
8	**com8**	49	6134	1962	819	4682	1746	465			
9	**com9**	2	0	40	46	6	5	14			
10	**com10**	3	42	349	44	1	64	1149	30	2	
11	**com11**	0	9	64	0	2	1	485	1		
12	**com12**	0	20	0			0	2	0		
13	**com13**	17	2833	351	0	18	3	692	6	5	
14	**com14**	2	44	2020	18	29	236	201	1459	5	6
15	**com15**	2	69	932	1	2	1	401	269	35	0
16	**com16**	158	4769	3696	20	7	16	45122	525	45	
17	**com17**	29	1788	842	102	5	95	926	51		
18	**com18**	56	2314	797	11	5	142	2012	468	0	
19	**com19**	46	77	372	37	20	201	670	0	4	
20	**com20**	128	19526	8307	7	40	0	3881	1		
21	**com21**	20	2598	1870	19	7	13	3062	20	0	
22	**com22**	59	61	76	0	7	3	173	23	0	
23	**com23**	0	3	109	1	1	0	54	156	18	
24	**com24**	18	418	2221	1	3	62	17891	4710		
25	**com25**	14	0	22	2	79		221	1542		
26	**com26**	3	42	883	0	7	107	2531	5	9	
27	**com27**	16	1	60		0	49	82	1	0	
28	**com28**	0		0				6385	8		
29	**com29**	0	14	952	2	0	5	16	2	4	
30	**com30**		85	76							
31	**com31**	12	4787	6439	25	225	177	7336	1920	26	
32	**com32**	2	16	332	28	43	39	1157	139	1	
33	**com33**	238	8983	2730	170			43558			766
34	**com34**	4371	4566	226	2	1		17586	14	32	
35	**com35**	7		173	497	154	1	7639	103	130	0
36	**com36**	17		911	110	7	0	111	20	3	0
37	**com37**	81	2578	126	189	1		1249	291		
38	**com38**	40	182	107	0	772		0			
39	**com39**	0	5995	2		5	32	740	30		
40	**com40**	22825	147578	22941	28	1680	943	51042	18682	520	6
41	**com41**	38	4986	4202	21	9	279	39535	2056	428	
42	**com42**	497	2407	1068	34	222	156	9476	521	6625	
43	**com43**	64	2625	697		350	788	3927	700	25	
44	**com44**	4	127	102	1		0	1176	2217		
45	**com45**	1156	440	18378	9018	167	957	10389	7698	550	
46	**com46**	24	2275	844	5	338	262	2475	2491		
47	**com47**	7	1819	1628	19	71	44	2361	1848	136	
48	**com48**	4		8		37	35	356	154		
49	**com49**	625	14243	470	81			3840	7299	2125	0
50	**com50**	3	10801	200		282	137	20640	1654		
51	**com51**	1	10	85		15	302	5451	119	8	
52	**com52**	0	18	140	11	0		394	173	12	
53	**com53**	20	1338	1147	88	3	15	1041	74		

54	**com54**	6		325		76	27	758			
55	**com55**			0		0		1210	3		
56	**com56**	0	311	30	74	1	0	83	243		
57	**com57**										
58	**act1**										
59	**act2**										
60	**act3**										
61	**act4**										
62	**act5**										
63	**act6**										
64	**act7**										
65	**act8**										
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68	**act11**										
69	**act12**										
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73	**act16**										
74	**act17**										
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77	**act20**										
78	**act21**										
79	**act22**										
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85	**act28**										
86	**act29**										
87	**act30**										
88	**act31**										
89	**act32**										
90	**act33**										
91	**act34**										
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93	**act36**										
94	**act37**										
95	**act38**										
96	**act39**										
97	**act40**										
98	**act41**										
99	**act42**										
100	**act43**										
101	**act44**										
102	**act45**										
103	**act46**										

104	**act47**										
105	**act48**										
106	**act49**										
107	**act50**										
108	**act51**										
109	**act52**										
110	**act53**										
111	**act54**										
112	**act55**										
113	**act56**										
114	**act57**										
115	**K**	16330	141841	139801	11994	3285	4257	157042	26925	18379	2386
116	**L**	3107	76397	13469	3750	5592	7719	138405	22518	17432	2668
117	**F**										
118	**H1**										
119	**H2**										
120	**H3**										
121	**H4**										
122	**H5**										
123	**H6**										
124	**H7**										
125	**H8**										
126	**H9**										
127	**H10**										
128	**G**										
129	**TC**										
130	**TE**										
131	**TK**	1	1209	1379	383	106	98	8868	892	2976	14
132	**TI**	1121	8482	4724	1371	182	139	8424	175	2221	5
133	**TM**										
134	**TY**										
135	**I**										
136	**R**										
137	**Total**	51700	511657	256187	29713	18809	20319	674075	108476	51807	5852

		101	102	103	104	105	106	107	108	109	110
		act44	**act45**	**act46**	**act47**	**act48**	**act49**	**act50**	**act51**	**act52**	**act53**
1	**com1**		3430	799	0	237	62	79	171	220	7
2	**com2**		4	13		11	4	6	5	4	1
3	**com3**		4				2	1011	101	535	2
4	**com4**		21	1	0	0	6	16	81	437	47
5	**com5**		10		0	2	28		18	2	1
6	**com6**						32				
7	**com7**	0	60	7	4	509	277	1000	73	27	88
8	**com8**	9	236	17	0	3	27	1687	952	3479	96
9	**com9**		8			0	0	212	5	33	3
10	**com10**	0	60	1	0	59	56	21	443	2384	323

11	**com11**	1	4	0	0	1	57	5	46	97	16
12	**com12**		0	0		0	0		0	0	0
13	**com13**		265	1	0	7	157	135	475	483	117
14	**com14**	1	184	2	86	35	355	334	1273	215	64
15	**com15**	0	299	3	28	35	330	10455	1560	128	108
16	**com16**	10	4820	249	13	43	138	302	170	78	147
17	**com17**	0	73	47	6	27	288	229	587	7198	6
18	**com18**	0	79	21	14	24	378		460	681	205
19	**com19**	1	391	1	10	14	681	16	443	284	103
20	**com20**	5	426	1	27	62	27720	5	85	25	3
21	**com21**	0	108	13	25	76	440	11	599	374	324
22	**com22**	0	22	9	4	41	98	7	5	0	6
23	**com23**	0	14	0	245	33	51	1769	148	115	4
24	**com24**	0	362	11	37	533	1276	272	663	481	56
25	**com25**	0	1	0	1	15	28	40	34	10	5
26	**com26**	9	7		3	19	97	1436	14	847	26
27	**com27**	0	26	13	1	22	32	272	5	3	1
28	**com28**		63			0	27	1839	0	30	
29	**com29**	0	9	0	1	17	8	90	91	10	17
30	**com30**						9				
31	**com31**	36	8320	52	163	80	203	11768	9086	7389	665
32	**com32**	0	834	2	10	24	21	3029	918	316	25
33	**com33**	594	40774			107	4159	3619	2001	2053	2848
34	**com34**	94	435	176	7	22	173	1622	122	407	62
35	**com35**	0	91	13	9	458	350	3941	1065	2386	533
36	**com36**	0			3	48	35	448	143	445	28
37	**com37**	4	282	11	27	56	485	795		280	27
38	**com38**		1201			0	70	0	0	401	253
39	**com39**		50		10	23	102	769	1395	1078	
40	**com40**	177	3658	623	203	546	4220	8253	427	966	1391
41	**com41**	224	4705	31	490	241	1018	7656	1016	447	591
42	**com42**	637	1890	124	69	155	484	35	13	2376	5084
43	**com43**	719	1260	89	409	19	1204			1	950
44	**com44**	264	78	3	207	106	560	13150			1987
45	**com45**	7715	25321	912	3322	4504	13097	5737	8534	1045	10846
46	**com46**	20	342	964	126	32	1266				9
47	**com47**	91	587	2	3296	326	652	2228	1213	605	632
48	**com48**	2	210		602	3689	1255	2681	6611	3806	116
49	**com49**	1152	6059	26	1875	1926	29804	7657	2145	1174	6390
50	**com50**	26	157	1	4	52	39		758	937	219
51	**com51**	46	22	1	31	26	270	91	3337	1589	658
52	**com52**	1	48	0	1	117	33	73	5115	8758	1673
53	**com53**	24	2708	23	28	19	974	96	2447	4833	1855
54	**com54**		7		0	0	98				
55	**com55**	1	0		1	0	28	39	51	13	9
56	**com56**		322	23	15	2	61		1	420	1505
57	**com57**										
58	**act1**										
59	**act2**										
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111	**act54**										
112	**act55**										
113	**act56**										
114	**act57**										
115	**K**	16090	191571	6518	1007	6122	62388	23800	31280	11058	6322
116	**L**	37454	45630	654	9520	9427	73449	58872	95884	57787	6094
117	**F**										
118	**H1**										
119	**H2**										
120	**H3**										
121	**H4**										
122	**H5**										
123	**H6**										
124	**H7**										
125	**H8**										
126	**H9**										
127	**H10**										
128	**G**										
129	**TC**										
130	**TE**										
131	**TK**	24	396	14	38	61	1014	59	125	148	144
132	**TI**	1398	1629		50	56	29	4746	86	48	776
133	**TM**										
134	**TY**										
135	**I**										
136	**R**										
137	**Total**	66830	349573	11474	22028	30071	230204	182413	182277	128943	53467

		111	112	113	114	115	116	117	118	119	120
		act54	**act55**	**act56**	**act57**	**K**	**L**	**F**	**H1**	**H2**	**H3**
1	**com1**		58	60	15				3735	4659	5425
2	**com2**		2	201					15	19	22
3	**com3**		4	0					2	2	2
4	**com4**	6	28	29					1875	2264	2464
5	**com5**		1								
6	**com6**			0							
7	**com7**		3	35					253	305	332
8	**com8**		288	473					56789	67087	80135
9	**com9**		13	4					3028	3581	4282
10	**com10**		51	365					1138	1350	1605
11	**com11**		3	76					4181	6388	8473
12	**com12**		0	0					878	1037	1227
13	**com13**	36	35	287					49	59	70
14	**com14**	45	1716	13					575	679	803
15	**com15**	426	955	2					553	771	956
16	**com16**	80	304	263					585	726	1613

17	**com17**		394	332					1720	2157	2782
18	**com18**		248	209					665	833	1074
19	**com19**	0	39	89					237	298	385
20	**com20**	5	106	247					1392	1755	2279
21	**com21**		26	592					56	70	90
22	**com22**		3	14					54	72	98
23	**com23**	0	5	0					5	7	10
24	**com24**		325	59					411	615	940
25	**com25**		66	1					58	87	133
26	**com26**		2	417					102	153	233
27	**com27**	5	23	14					6	24	87
28	**com28**		0	10					0	1	2
29	**com29**	3	5	1					2198	2598	3076
30	**com30**								0	1	1
31	**com31**	978	942	686					7771	9301	10247
32	**com32**		17	97					760	912	1008
33	**com33**		217	61					288	467	673
34	**com34**		22	12					18	30	67
35	**com35**	14	83	27					111	164	201
36	**com36**	4	125	10					3077	4537	5537
37	**com37**	805	2732	9					349	477	631
38	**com38**		72	3					281	385	510
39	**com39**		11	5	73				159	218	290
40	**com40**	60	182	159	121				1682	2679	3506
41	**com41**	311	1824	87					1080	1652	1737
42	**com42**		193	152					9	8	22
43	**com43**		45	7					0	0	0
44	**com44**		69	83					2	2	4
45	**com45**	6398	1768	481					109	101	270
46	**com46**		94	75							
47	**com47**	54	36	15					2	3	4
48	**com48**		32								
49	**com49**		1509	45					535	828	1065
50	**com50**		12	12							
51	**com51**		5	0	422				570	1037	1631
52	**com52**		26	90					2225	3045	3234
53	**com53**	593	104	451					995	1244	1276
54	**com54**		10	0					490	728	896
55	**com55**	2	393	0					93	145	283
56	**com56**		37	899	172				157	348	428
57	**com57**				27				103	158	203
58	**act1**										
59	**act2**										
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112	**act55**										
113	**act56**										
114	**act57**										
115	**K**	772	1656	2564	2488						
116	**L**	11613	13431	7181							

117	**F**					1145140		50408	267	239	404
118	**H1**					16493	17615	438	55	70	104
119	**H2**					26684	30719	393	81	102	151
120	**H3**					37446	52057	664	97	123	182
121	**H4**					41688	55935	1419	85	108	159
122	**H5**					47757	81326	2119	97	123	181
123	**H6**					74326	109938	1321	102	129	191
124	**H7**					74936	147694	2553	107	136	200
125	**H8**					103074	188108	3292	123	156	230
126	**H9**					134330	261577	8518	143	181	267
127	**H10**					223504	473682	125166	203	257	380
128	**G**					39465		57492	4737	6985	9194
129	**TC**										
130	**TE**										
131	**TK**		90	6							
132	**TI**		32	14							
133	**TM**										
134	**TY**							182194	2041	3010	3962
135	**I**							719935	-62729	-63029	-58962
136	**R**						11137	184188			
137	**Total**	22211	30473	17025	3319	1964842	1429789	1340099	46839	74659	108966

		121	122	123	124	125	126	127	128	129	130
		H4	**H5**	**H6**	**H7**	**H8**	**H9**	**H10**	**G**	**TC**	**TE**
1	**com1**	6639	6240	7498	7527	7897	9027	7757	15892		
2	**com2**	27	26	31	31	32	37	32	252		
3	**com3**	3	3	3	3	3	4	3	8		
4	**com4**	2825	2742	2946	3201	3281	3437	2353	12		
5	**com5**										
6	**com6**										
7	**com7**	380	369	396	429	439	457	306			
8	**com8**	83335	90260	97954	106015	117274	130615	155514	253		
9	**com9**	4456	4831	5248	5687	6306	7059	8622			
10	**com10**	1620	1852	2026	2412	2885	3486	5408	0		
11	**com11**	9128	10874	13678	16150	19438	26094	37909			
12	**com12**	1236	1406	1531	1812	2146	2537	3515			
13	**com13**	70	80	87	104	124	149	225			
14	**com14**	809	920	1002	1185	1403	1657	2282			
15	**com15**	1027	1275	1459	1714	2005	2460	3229	21		
16	**com16**	1421	2074	2899	3533	4435	5947	10430	12605		
17	**com17**	2714	3107	3497	3918	4575	5339	6478	460		
18	**com18**	1047	1198	1348	1509	1760	2049	2452	122		
19	**com19**	376	432	487	548	644	761	987	468		
20	**com20**	2229	2567	2905	3277	3874	4644	6425			
21	**com21**	88	101	114	127	149	173	209			

22	**com22**	98	118	139	165	212	296	673			
23	**com23**	12	14	18	23	34	39	68			
24	**com24**	1095	1247	1617	2058	3032	3472	6129			
25	**com25**	155	177	230	294	435	503	941			
26	**com26**	272	310	402	511	754	865	1545	168		
27	**com27**	90	226	600	686	815	2030	9379			
28	**com28**	2	6	16	19	22	55	258	29		
29	**com29**	3099	3529	3847	4560	5412	6427	9133	0		
30	**com30**	1	1	1	2	2	3	5			
31	**com31**	10584	12144	12493	14018	15854	18467	23883	3168		
32	**com32**	1043	1200	1238	1393	1585	1868	2542	391		
33	**com33**	751	962	1085	1363	2066	2995	8452			
34	**com34**	32	136	229	399	390	826	1870			
35	**com35**	230	293	349	423	552	750	1197	179		
36	**com36**	6340	8064	9571	11573	15024	20185	30559	8		
37	**com37**	790	1031	1438	1761	2553	3430	5922			
38	**com38**	640	837	1171	1439	2098	2853	5221	0		
39	**com39**	364	476	666	819	1197	1635	3045			
40	**com40**	3985	4960	6200	7318	9216	11663	15443	19892		
41	**com41**	1887	2412	2779	3165	3943	5511	9624	2		
42	**com42**	23	23	26	49	40	88	110	14087		
43	**com43**	0	0	0	1	0	1	1	2		
44	**com44**	4	4	5	9	8	17	24	6321		
45	**com45**	282	283	317	607	492	1074	1310	1		
46	**com46**										
47	**com47**	5	6	7	9	12	16	27	3743		
48	**com48**								478		
49	**com49**	1037	1397	1523	1879	2240	2800	4360	137470		
50	**com50**								113617		
51	**com51**	1847	2822	3874	5175	7361	12550	21476	74863		
52	**com52**	4083	4768	4793	5149	7121	8014	12566	13678		
53	**com53**	1356	1791	1712	2091	2345	2955	4574			
54	**com54**	1030	1319	1577	1924	2537	3521	6181	254		
55	**com55**	338	448	716	924	1343	2286	5893	16553		
56	**com56**	527	621	790	1038	1603	2076	4591			
57	**com57**	198	266	289	356	422	522	774			
58	**act1**										
59	**act2**										
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111	**act54**										
112	**act55**										
113	**act56**										
114	**act57**										
115	**K**										
116	**L**										
117	**F**	865	1291	805	1555	2006	5190	76267	19226		
118	**H1**	117	151	169	192	262	343	597	6928		
119	**H2**	170	220	246	280	381	499	869	9054		
120	**H3**	206	266	297	338	460	602	1049	9368		
121	**H4**	180	233	260	296	402	527	918	13249		

122	**H5**	205	265	296	336	457	599	1043	12942		
123	**H6**	216	279	312	354	482	631	1100	11745		
124	**H7**	227	293	327	372	506	663	1155	11128		
125	**H8**	260	336	376	427	581	761	1327	10942		
126	**H9**	302	391	436	496	675	884	1540	9420		
127	**H10**	429	555	620	705	959	1256	2189	8187		
128	**G**	10908	13093	15545	18471	22396	28699	49764	48065	78690	81049
129	**TC**										
130	**TE**										
131	**TK**										
132	**TI**										
133	**TM**										
134	**TY**	4700	5642	6699	7959	9651	12367	21444			
135	**I**	-59878	-51741	-23999	-15474	8730	48938	239039	313544		
136	**R**								47927		
137	**Total**	120538	153521	207214	246691	317338	427686	850213	966724	78690	81049

		131	132	133	134	135	136	137
		TK	**TI**	**TM**	**TY**	**I**	**R**	**Total**
1	**com1**						111325	392260
2	**com2**					70	222	5244
3	**com3**						22	17256
4	**com4**						34674	104131
5	**com5**					133058	757782	1152189
6	**com6**					190	7020	217470
7	**com7**					631	8685	30476
8	**com8**						13905	1043214
9	**com9**					1920	1927	59965
10	**com10**						4678	68480
11	**com11**						371	176369
12	**com12**					111	2805	22472
13	**com13**						966	27896
14	**com14**					315	644	48599
15	**com15**					6085	308	42777
16	**com16**					22617	38100	222427
17	**com17**						36382	125048
18	**com18**					300	331	48327
19	**com19**					232	237	57503
20	**com20**					140456	436836	777036
21	**com21**						3956	71820
22	**com22**					108530	9373	161372
23	**com23**					9859	387	13402
24	**com24**					30599	8707	160595
25	**com25**					2625		8785
26	**com26**					10387	1914	26951
27	**com27**							17401
28	**com28**					19667		34073
29	**com29**						8392	53679

30	**com30**							13507
31	**com31**						655	321214
32	**com32**							33943
33	**com33**					377812	115	615870
34	**com34**						143	51773
35	**com35**					136653	194112	511795
36	**com36**					94761	36491	257020
37	**com37**							29910
38	**com38**							18831
39	**com39**							20323
40	**com40**					4733	2779	751428
41	**com41**						8509	117151
42	**com42**						1984	66758
43	**com43**						71	15490
44	**com44**							66830
45	**com45**							349712
46	**com46**						883	16018
47	**com47**						39	24244
48	**com48**							30071
49	**com49**						11654	324673
50	**com50**						34252	187593
51	**com51**							182371
52	**com52**							129037
53	**com53**							53563
54	**com54**							22211
55	**com55**						53	30826
56	**com56**							17057
57	**com57**							3319
58	**act1**							379531
59	**act2**							4619
60	**act3**							17194
61	**act4**							103010
62	**act5**							1055821
63	**act6**							207316
64	**act7**							27296
65	**act8**							539798
66	**act9**							51547
67	**act10**							53970
68	**act11**							88176
69	**act12**							4544
70	**act13**							15190
71	**act14**							6527
72	**act15**							25985
73	**act16**							168805
74	**act17**							37518
75	**act18**							10277
76	**act19**							34701
77	**act20**							687463
78	**act21**							22568
79	**act22**							24899
80	**act23**							812

81	**act24**							8724
82	**act25**							8417
83	**act26**							3483
84	**act27**							3546
85	**act28**							33969
86	**act29**							10795
87	**act30**							13507
88	**act31**							315513
89	**act32**							33927
90	**act33**							483703
91	**act34**							51700
92	**act35**							511657
93	**act36**							256187
94	**act37**							29713
95	**act38**							18809
96	**act39**							20319
97	**act40**							674075
98	**act41**							108476
99	**act42**							51807
100	**act43**							5852
101	**act44**							66830
102	**act45**							349573
103	**act46**							11474
104	**act47**							22028
105	**act48**							30071
106	**act49**							230204
107	**act50**							182413
108	**act51**							182277
109	**act52**							128943
110	**act53**							53467
111	**act54**							22211
112	**act55**							30473
113	**act56**							17025
114	**act57**							3319
115	**K**							1964842
116	**L**						595	1429789
117	**F**						36435	1340099
118	**H1**						3305	46839
119	**H2**						4811	74659
120	**H3**						5810	108966
121	**H4**						5081	120538
122	**H5**						5777	153521
123	**H6**						6088	207214
124	**H7**						6394	246691
125	**H8**						7345	317338
126	**H9**						8526	427686
127	**H10**						12119	850213
128	**G**	110459	112043		259668			966724
129	**TC**							78690
130	**TE**							81049
131	**TK**							110459

132	**TI**							112043
133	**TM**			0				0
134	**TY**							259668
135	**I**						107236	1101610
136	**R**							1991213
137	**Total**	110459	112043	0	259668	1101610	1991213	

Appendix E – Chapter 6

E.1. Key to the Notations

i – Row index in the IO system

j – Column index in the IO system

x_{ij}^{b} – Intermediate demand of industry *j* for products of industry *i* in basic prices.

x_{ij}^{c} – Intermediate demand of industry *j* for products of industry *i* in consumer prices.

y_{i}^{b} – Final demand for products of industry *j* in basic prices.

y_{i}^{c} – Final demand for products of industry *j* in consumer prices.

z_{i}^{b} – Total demand for products of industry *i* in basic prices.

z_{i}^{c} – Total demand for products of industry *i* in consumer prices.

z_{j}^{b} – Total output of industry *j* products in basic prices.

t_{ij} – Indirect tax on industry *j* intermediate purchases of industry *i* products.

t_{i}^{y} – Indirect tax on final purchases, investments and export of industry *i* products.

v_{j} – Value added of industry *j*.

trd_{ij} – Trade margin on industry *j* intermediate purchases of industry *i* products.

trd_{i}^{y} – Trade margin on final purchases, investments and export of industry *i* products.

$tran_{ij}$ – Transport margin on industry *j* intermediate purchases of industry *i* products.

$tran_{i}^{y}$ – Trade margin on final purchases, investments and export of industry *i* products.

$E = \begin{pmatrix} 1 \\ \vdots \\ 1 \end{pmatrix}$ - Column vector of dimension nx1.

$X^{c} = \begin{pmatrix} x_{11}^{c} & \dots & x_{1n}^{c} \\ \vdots & \ddots & \vdots \\ x_{n1}^{c} & \cdots & x_{nn}^{c} \end{pmatrix}$ - Matrix of intermediate demands in consumer prices

$Z^b = \begin{pmatrix} z_1^b & \cdots & z_n^b \end{pmatrix}$ - Row vector of total output at basic prices

$Y^c = \begin{pmatrix} y_1^c \\ \vdots \\ y_n^c \end{pmatrix}$ - Column vector of final demands in consumer prices

$V = \begin{pmatrix} v_1 & \cdots & v_n \end{pmatrix}$ - Row vector of value added in basic prices

$T = \begin{pmatrix} t_{11} & \cdots & t_{1n} \\ \vdots & \ddots & \vdots \\ t_{n1} & \cdots & t_{nn} \end{pmatrix}$ - Matrix of indirect taxes on intermediate demand

$T^y = \begin{pmatrix} t_1^y \\ \vdots \\ t_n^y \end{pmatrix}$ - Column vector of indirect taxes on final demand.

$M = \begin{pmatrix} trd_{11} & \cdots & trd_{1n} \\ \vdots & & \vdots \\ trd_{k1}^{trade} = -\sum_{i \neq k} trd_{i1} & \cdots & trd_{kn}^{trade} = -\sum_{i \neq k} trd_{in} \\ \vdots & & \vdots \\ trd_{n1} & \cdots & trd_{nn} \end{pmatrix}$ – Matrix of trade margins on intermediate demand, where k represent the trade sector

$M^y = \begin{pmatrix} trd_1^y \\ \vdots \\ trd_k^y = -\sum_{i \neq k} trd_i^y \\ \vdots \\ trd_n^y \end{pmatrix}$ - Column vector of trade margins on final demand.

$R = \begin{pmatrix} tran_{11} & \cdots & tran_{1n} \\ \vdots & & \vdots \\ tran_{l1}^{transport} = -\sum_{i \neq k} tran_{i1} & \cdots & tran_{ln}^{transport} = -\sum_{i \neq k} tran_{in} \\ \vdots & & \vdots \\ tran_{n1} & \cdots & tran_{nn} \end{pmatrix}$ – Matrix of transport margins on intermediate demand and index l is for the transport sector

$$R^y = \begin{pmatrix} tran_1^y \\ \vdots \\ tran_k^y = -\sum_{i \neq k} tran_i^y \\ \vdots \\ tran_n^y \end{pmatrix}$$ - Column vector of transport margins on final demand.

$$D = \begin{pmatrix} d_{11} & \dots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \dots & d_{nn} \end{pmatrix} -$$ Matrix of margin shares,

where $d_{ij}\big|_{i=j} = \frac{m_i}{z_i^c}$

E.2. Tables

Table E.2.1. Trade Margin Shares of the Total Domestic Production

ISIC Rev. 3.1			Kazakhstan 2001	Kazakhstan 2002	Kazakhstan 2005	Australia 2002	Canada 2000
	1	Agriculture and hunting	8%	7%	16%	13%	11%
A	2	Forestry	7%	8%	35%	4%	1%
B	5	Fishing	5%	8%	41%	19%	11%
	10	Mining of coal, lignite and peat	7%	7%	2%	0%	3%
	11	**Extraction of crude oil and natural gas**	**23%**	**18%**	**9%**	**1%**	**0%**
C	12-14	Other mining and quarrying	3%	3%	19%	1%	1%
	15	Manufacture of food products and beverages	34%	35%	20%	20%	19%
	16	Manufacture of tobacco products	16%	24%	33%	16%	15%
	17	Manufacture of textiles	20%	29%	34%	26%	15%
	18	Manufacture of wearing apparel	5%	11%	53%	64%	30%
	19	Manufacture of luggage, handbags, footwear, etc.	24%	19%	51%	19%	60%
	20	Manufacture of wood	6%	5%	30%	11%	6%
	21	Manufacture of paper and paper products	0%	1%	41%	25%	13%
	22	Publishing and printing	18%	14%	37%	20%	12%
	23	Manufacture of coke and refined petroleum products	12%	14%	35%	11%	17%
	24	Manufacture of chemicals and chemical products	6%	6%	41%	34%	27%
	25	Manufacture of rubber and plastics products	1%	0%	32%	26%	15%
	26	Manufacture of other non-metallic mineral products	4%	3%	34%	12%	14%
	27	Manufacture of basic metals	22%	12%	8%	17%	8%
	28	Manufacture of fabricated metal products	10%	4%	39%	7%	16%
	29	Manufacture of machinery and equipment n.e.c.	6%	11%	47%	37%	26%
D	30-37	Other manufacturing	8%	9%	41%	46%	17%
E	40-41	Electricity, gas, steam and hot water supply; Collection, purification and distribution of water	16%	15%	0%	0%	0%
F	45	Construction	16%	13%	0%	0%	0%
G	50-52	Wholesale and retail trade	-376%	-588%	-658%	-283%	-1801%

H	55	Hotels and restaurants	-48%	0%	0%	0%	0%
I	60-63	Transport, storage and communications	0%	0%	0%	0%	0%
	64	Post and telecommunications	0%	0%	0%	0%	0%
J + K	65-67, 70-74	Financial intermediation; Real estate, renting and business activities	0%	0%	0%	0%	0%
L	75	Public administration and defense; compulsory social security	0%	0%	0%	0%	0%
M	80	Education	0%	0%	0%	0%	0%
N	85	Health and social work	0%	0%	0%	0%	0%
O	90-93	Other community, social and personal service activities	0%	0%	0%	0%	0%
P	95-97	Activities of private households as employers of domestic staff	0%	0%	0%	0%	0%
Q	99	Extraterritorial organizations and bodies	0%	0%	0%	0%	94%
		Total	**11%**	**10%**	**11%**	**8%**	**7%**

Table E.2.2. Change in Value Added Using Austalian (AU) and Canadian (CA) Margins (% of total)

ISIC Rev. 3.1			2001 AU	2001 CA	2005 AU	2005 CA
A	1	Agriculture and hunting	-0.9	-0.4	0.3	0.6
	2	Forestry	0.0	0.0	0.0	0.0
B	5	Fishing	-0.1	-0.0	0.0	0.0
C	10	Mining of coal, lignite and peat	0.2	0.1	0.0	0.0
	11	**Extraction of crude oil and natural gas**	**7.6**	**8.1**	**3.0**	**3.5**
	12-14	Other mining and quarrying	0.1	0.1	1.1	1.1
D	15	Manufacture of food products and beverages	1.8	2.0	-0.0	0.0
	16	Manufacture of tobacco products	0.0	0.0	0.2	0.3
	17	Manufacture of textiles	-0.1	0.1	0.0	0.1
	18	Manufacture of wearing apparel	-0.3	-0.1	-0.0	0.1
	19	Manufacture of luggage, handbags, footwear, etc.	0.0	-0.1	0.2	-0.0
	20	Manufacture of wood	-0.0	-0.0	0.0	0.1
	21	Manufacture of paper and paper products	-0.1	-0.0	0.1	0.2
	22	Publishing and printing	-0.0	0.0	0.3	0.5
	23	Manufacture of coke and refined petroleum products	0.1	-0.5	1.4	1.0
	24	Manufacture of chemicals and chemical products	-0.5	-0.4	0.1	0.2
	25	Manufacture of rubber and plastics products	-0.1	-0.0	0.0	0.1
	26	Manufacture of other non-metallic mineral products	-0.1	-0.1	0.7	0.6
	27	Manufacture of basic metals	0.3	0.9	-1.5	0.1
	28	Manufacture of fabricated metal products	0.4	-1.0	0.4	0.3
	29	Manufacture of machinery and equipment n.e.c.	-0.5	-0.3	0.4	0.9
	30-37	Other manufacturing	-1.1	-0.3	-0.4	1.8
E	40-41	Electricity, gas, steam and hot water supply; Collection, purification and distribution of water	1.3	1.3	-0.0	-0.0
F	45	Construction	2.5	2.5	-0.1	-0.0
G	50-52	Wholesale and retail trade	-10.0	-11.0	-6.4	-11.2
H	55	Hotels and restaurants	-0.4	-0.4	-0.0	-0.0
I	60-63	Transport, storage and communications	-0.2	-0.2	-0.2	-0.3
	64	Post and telecommunications	-0.0	-0.0	-0.0	-0.0
J + K	65-67, 70-74	Financial intermediation; Real estate, renting and business activities	0.1	-0.0	0.0	-0.1
L	75	Public administration and defense; compulsory social security	-0.0	-0.0	-0.0	-0.0
M	80	Education	-0.0	-0.0	-0.0	-0.0
N	85	Health and social work	-0.0	-0.0	-0.0	-0.0
O	90-93	Other community, social and personal service activities	0.0	0.0	-0.0	-0.0
P	95-97	Activities of private households as employers of domestic staff	0.0	0.0	0.0	0.0
Q	99	Extraterritorial organizations and bodies	0.0	0.0	0.0	0.0

Table E.2.3. Adjusted Structure of the Value Added (where KZ represent original Kazakhstan's trade margins, % of total)

ISIC Rev. 3.1			2001 KZ	2001 AU	2001 CA	2005 KZ	2005 AU	2005 CA
A	1	Agriculture and hunting	9.0	8.1	8.6	5.8	6.2	6.4
	2	Forestry	0.1	0.1	0.1	0.1	0.1	0.1
B	5	Fishing	0.2	0.1	0.2	0.1	0.1	0.1
C	10	Mining of coal, lignite and peat	0.9	1.1	1.0	0.5	0.5	0.5
	11	**Extraction of crude oil and natural gas**	**8.5**	**16.1**	**16.6**	**17.3**	**20.3**	**20.8**
	12-14	Other mining and quarrying	2.7	2.8	2.9	2.1	3.2	3.3
D	15	Manufacture of food products and beverages	4.0	5.9	6.0	2.3	2.3	2.4
	16	Manufacture of tobacco products	0.3	0.3	0.4	0.4	0.6	0.6
	17	Manufacture of textiles	0.5	0.4	0.6	0.2	0.3	0.4
	18	Manufacture of wearing apparel	0.2	-0.1	0.1	0.1	0.0	0.1
	19	Manufacture of luggage, handbags, footwear, etc.	0.1	0.1	-0.0	0.1	0.3	0.1
	20	Manufacture of wood	0.2	0.2	0.2	0.1	0.1	0.1
	21	Manufacture of paper and paper products	0.1	-0.0	0.0	0.2	0.3	0.4
	22	Publishing and printing	0.2	0.2	0.3	0.5	0.8	1.0
	23	Manufacture of coke and refined petroleum products	2.2	2.2	1.6	1.1	2.5	2.1
	24	Manufacture of chemicals and chemical products	0.5	-0.0	0.1	0.2	0.3	0.4
	25	Manufacture of rubber and plastics products	0.1	0.0	0.0	0.2	0.3	0.4
	26	Manufacture of other non-metallic mineral products	0.4	0.3	0.3	0.9	1.6	1.5
	27	Manufacture of basic metals	7.0	7.3	7.9	7.1	5.6	7.2
	28	Manufacture of fabricated metal products	0.3	0.7	-0.7	0.3	0.7	0.6
	29	Manufacture of machinery and equipment n.e.c.	0.4	-0.0	0.1	0.9	1.4	1.9
	30-37	Other manufacturing	0.9	-0.2	0.6	1.6	1.2	3.4
E	40-41	Electricity, gas, steam and hot water supply; Collection, purification and distribution of water	3.0	4.2	4.2	2.2	2.2	2.2
F	45	Construction	5.8	8.3	8.3	11.5	11.4	11.5
G	50-52	Wholesale and retail trade	12.8	2.8	1.8	14.8	8.5	3.7
H	55	Hotels and restaurants	0.6	0.2	0.2	0.7	0.7	0.7
I	60-63	Transport, storage and communications	10.3	10.1	10.1	7.3	7.1	7.0
	64	Post and telecommunications	1.6	1.5	1.5	2.9	2.9	2.9
J + K	65-67, 70-74	Financial intermediation; Real estate, renting and business activities	16.5	16.5	16.4	11.6	11.6	11.6
L	75	Public administration and defense; compulsory social security	2.1	2.1	2.1	2.4	2.4	2.4
M	80	Education	3.9	3.9	3.9	2.0	2.0	2.0
N	85	Health and social work	2.2	2.2	2.2	1.1	1.1	1.1
O	90-93	Other community, social and personal service activities	2.1	2.2	2.2	1.0	1.0	1.0
P	95-97	Activities of private households as employers of domestic staff	0.2	0.2	0.2	0.2	0.2	0.2
Q	99	Extraterritorial organizations and bodies	0.0	0.0	0.0	0.0	0.0	0.0